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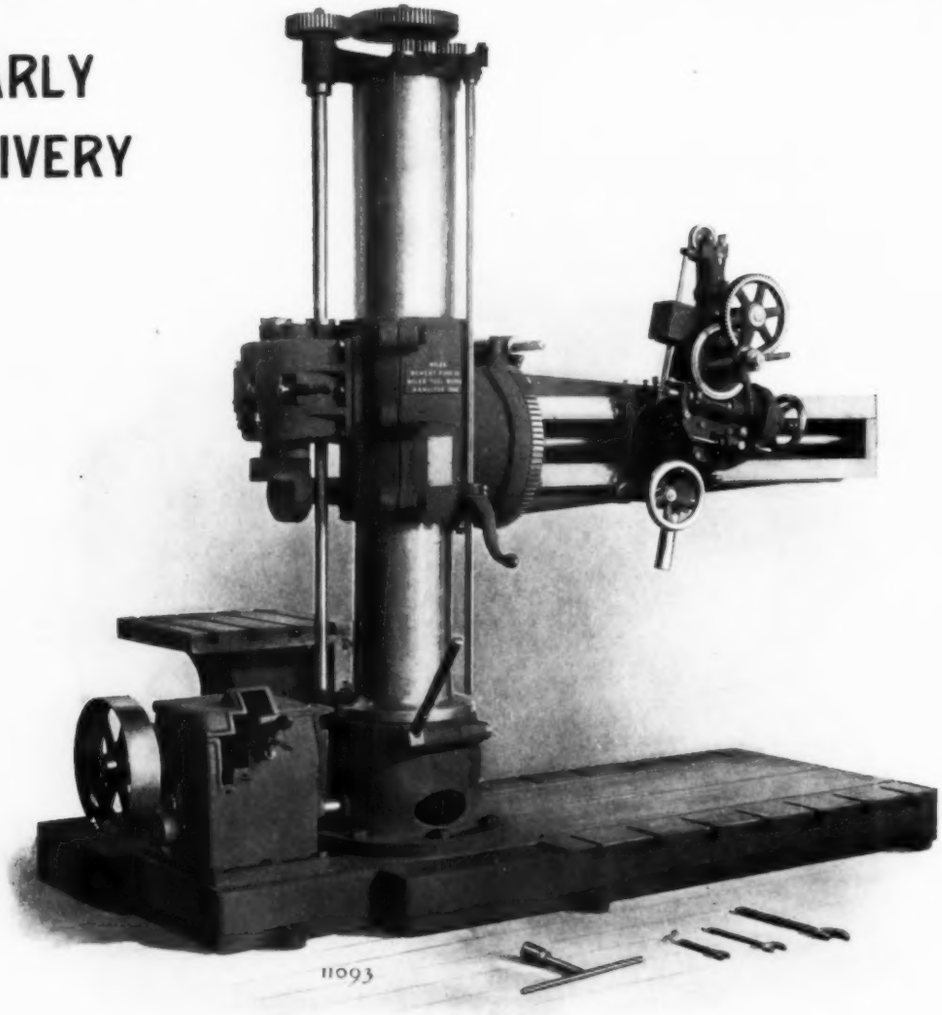

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A New Railway Car Dynamometer—II

Details of the Design of the Dynamometer and Some of the Difficulties Encountered and Overcome in the Precision Work of Making It

BY A. H. EMERY, JR.

In the first portion of this article, the writer described the Pennsylvania Railroad's new dynamometer car and explained in a general manner the dynamometer itself.

It will be remembered that all the load on the drawbar is transmitted directly to the piston of an hydraulic cylinder which is fastened to the framework of the car. A portion of the load on this piston is communicated hydraulically to the piston of a smaller cylinder, and the motion of this smaller piston is resisted by compression springs which measure the load on the drawbar by their compression. In other words, the whole apparatus is comparable with the measuring of the load on the piston rod of a steam engine, by means of an indicator.

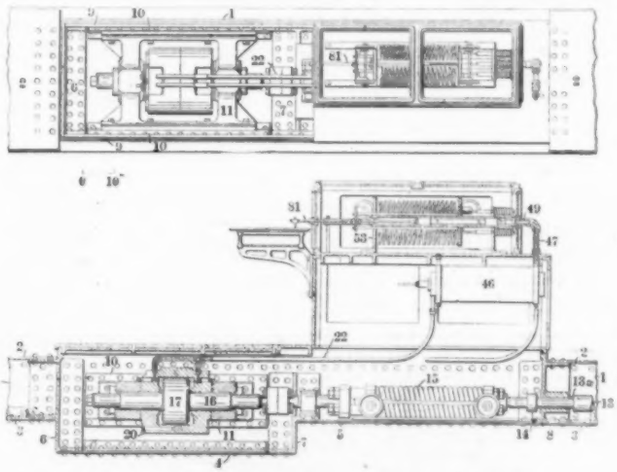


FIG. 1. GENERAL ARRANGEMENT OF DYNAMOMETER

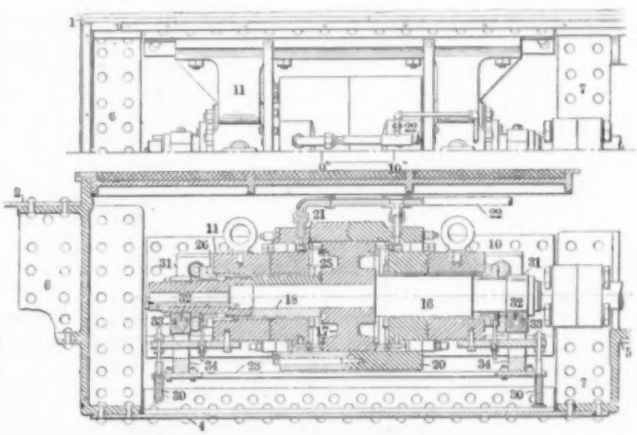


FIG. 2. DETAILS OF MAIN CYLINDER

Fig. 1 shows the general design of the dynamometer and the relative arrangement of the parts, except the supply tank, which is carried above the top of the upper case at its right-hand end.

A hollow box girder is formed of side plates 1 and 2, which run the whole length of the car, and top and bottom plates 3, 4 and 5, which run nearly the whole length of the car; this box girder is stiffened at each end by a heavy casting, and intermediately by several other castings, as at 6, 7 and 8. This girder forms the backbone of the car, is supported by the trucks, and carries the framework of the car and the drawbars. One of the drawbars is fastened in the ordinary manner through a Westinghouse friction draft gear, while the load on the other is transmitted to this backbone through the main press of the dynamometer. The part of this girder between castings 6 and 8 has no top, but is very heavily reinforced on the sides by plates 9 and 10; in the construction, the castings 6, 7 and 8 were very carefully finished and then riveted up with plates 4, 5, 9 and 10, after which the tops of 9 and the faces of 10, between which the housing 11 fits, were planed to gages and the ledge on plates 9 planed to an exact distance below the axis of the hole in casting 8. This was a very difficult piece of work to do, as everything had to be exactly right, the faces on 9 all exactly parallel to the center line of the girder and exactly equidistant from the axis of the hole.

The housing 11 fits between and rests upon a ledge on the plates 10, and is held by taper-reamed bolts which transmit all the load on the drawbar to the car frame. This load is transmitted by shaft 13, which extends to the right, nearly to the end of the car, where it is fastened to a large hollow casting which contains a Westinghouse friction draft gear connected to the drawhead. This casting moves in the casting which forms the end of the main girder, and is guided therein by six ball bearings, so that as little loss as possible will occur in friction.

The dynamometer is designed for a maximum load of 100,000 pounds, but in coupling up the train, or in a "run in," a load of 300,000 or even 500,000 pounds might come upon bar 13, and, to protect the mechanism from any undue load, safety springs 15 are put into the system. These springs have to transmit load in either direction, and the safety apparatus consists of three crossheads, the one at the left fixed to the extension of the piston rod of the main press of the dynamometer. There are four long bolts going through it and through the other two crossheads, and distance collars around these bolts between the two cross-heads at the left. These bolts are fast in the left-hand crosshead, but free to slip in the others.

The rod 13 passes through the right-hand and central crosshead and has round nuts upon it, resting against the cross-heads, the crossheads and springs being between the nuts. The springs are given an initial load of 100,000 pounds, which is carried on the nuts on the rod 13, and the nuts on the bolts are all screwed up until they rest against the crossheads; now, for all loads less than 100,000 pounds, in either direction, the apparatus acts as a solid bar. On the rod 13 is a shoulder 13A and a collar 14, which are so adjusted that when the piston 17 is in the center of the cylinder, it is exactly 1⅛ inches from the ends of the boss on the casting 8 to the shoulder 13A and to the collar 14.

If a pulling load comes on the bar 13, so long as it is less than 100,000 pounds, it is transmitted directly to the piston 17, the spring system acting as if it were rigid; but if it exceeds 100,000 pounds the springs begin to compress, the central crosshead moving away from the distance collars on the bolts, the right-hand nut on the rod 13 moving away from the right-hand crosshead and the collar 14 moving toward the boss on the casting 8. If the load becomes great enough to compress the springs 1⅛ inches, less whatever the piston 17 may have moved, the collar 14 will strike the casting 8 and all the load in excess of that on the springs will be transmitted directly to the backbone of the car.

Should the load be push instead of pull, the result will be the same, except that the motion of the crossheads will be reversed; that is, the right-hand one will move away from the nut on the four bolts, and the nut on the piston rod at the left of the center crosshead will move away from that crosshead and the shoulder 13A will strike the casting 8.

The Main Press

Fig. 2 shows the details of construction of the large cylinder or main press, and is a correct drawing to scale in every respect, except that the valves shown in the upper part are actually behind the central vertical plane, while those shown in the lower part are on the same level as the upper ones, but in a plane in front of the section.

The construction of this press, its piston, piston rod, etc., is very easily seen, but there are two points of interest which merit description.

The piston 17 and rod 16 are necessarily heavy, and as only a very small leakage is allowable, they must fit closely, but, as any friction is very undesirable, a close fit is out of the question. Also, any wear due to the constant motion of the piston and rod back and forth as the load changes would increase the leakage, and, what would be worse, might impair the accuracy of the whole instrument. Near either end of the piston rod are parts 31, which contain roller bearings 33, the shaft in the bearing being at right angles to the piston rod and forming the axle of a portion of a wheel 34. These wheels or rockers roll on a track 28, which is carried by compressing springs 30. By carefully adjusting the load on these springs, the weight of the piston and rod can be carried or balanced, so that the friction will be very small and the wear very greatly decreased.

The valves in the main press are so arranged that for either push or pull the side of the piston under load is in communication with the recording cylinder, and the other side is in communication with the supply tank.

Pipe 22, Fig. 1, leads from the main press to a chamber 46, the liquid entering the chamber through a throttling valve, leaving the chamber through pipe 47 and entering the rear of the recording cylinder. By this throttling valve, a dash-pot action is obtained and also the recording cylinder can be stopped off from the main press, allowing the springs to be changed during a run, if desired.

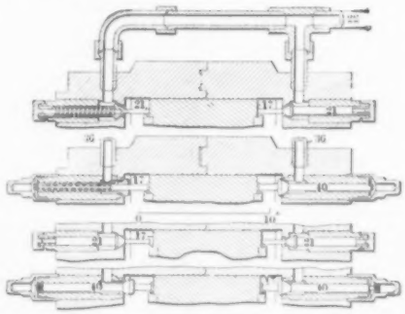


FIG. 3. DETAILS OF THE VALVES

In Fig. 3 details of the valves are shown. In the upper two sections the piston is at the center of its stroke, and the valves are so arranged that both pairs of valves 21 and 40 are open and the main press is therefore open to both the supply tank and the recording cylinder, giving a chance for all the working parts and the liquid to assume a normal position. As soon as the piston 17 moves in either direction one of the valves 21 closes, the valve 40 on the same side of the piston being pulled farther open, while the valve 21 on the opposite side of the piston is forced farther open and the valve 40 closed. The result is that no matter which way the piston moves from its central position, the liquid on the side which is carrying the load is able to pass through its valve 21 into the pipe 22 and thus to the recording cylinder, while the opposite side of the cylinder is opened through its valve 40, nipple 36, and the pipe connecting therewith to the supply tank, and is kept full of oil.

Fig. 4 is a photograph of the main cylinder, piston, piston rod, valves, etc., disassembled.

Fig. 5 shows the whole main press complete, ready for assembling in the car.

The Recording Cylinder

Fig. 6 shows a section of the recording cylinder, with two of the recording springs fastened in place. Figs. 7 and 8 are photographs of this part of the apparatus. These recording springs and their method of manufacture were described by the writer in the issue of November 29, 1906.

The liquid from the main press enters the recording cylinder through pipe 49, and acts against the pistons 65, of which there are four, to reduce the leakage to a very small amount. In order to reduce the friction and wear, and to get a very long bearing, so that the pistons will have no tendency to cramp in the cylinder, they are placed at the two ends of a long arbor 64; and, to further reduce the friction and wear, this arbor is provided with a pair of rollers 68 whose axles are carried in two side bars 70, the side bars, axles and wheels forming a little truck which carries the arbor and pistons on eight springs which are carefully adjusted so that they just carry the weight of the moving parts. This piston apparatus is clearly shown in the photograph, Fig. 7, but, unfortunately, is there shown upside down. The two ends of the recording cylinder 51 are supported by angle plates 52 and 53 which carry two rectangular bars 62 which form tracks for a four-wheel truck. Extending from the arbor carrying the pistons is a small rod 74 which connects it to crosshead 78 of this truck. This rod therefore transmits all the load on the pistons to the truck.

The recording springs are placed between the other crosshead of the truck and stanchion 53, which supports the cylinder. The outer end of the truck has at-

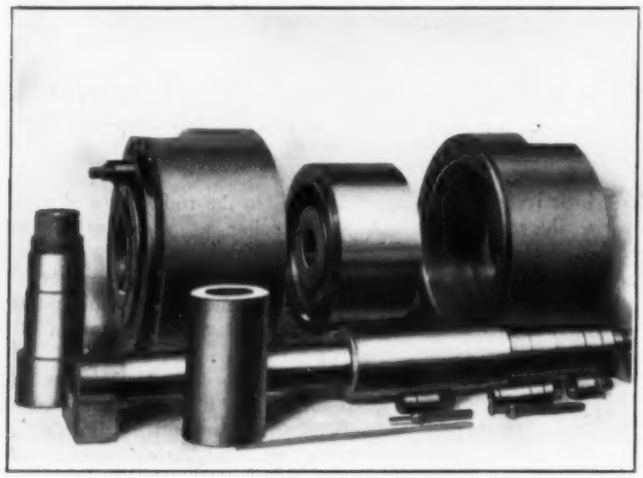


FIG. 4. PARTS OF THE MAIN PRESS

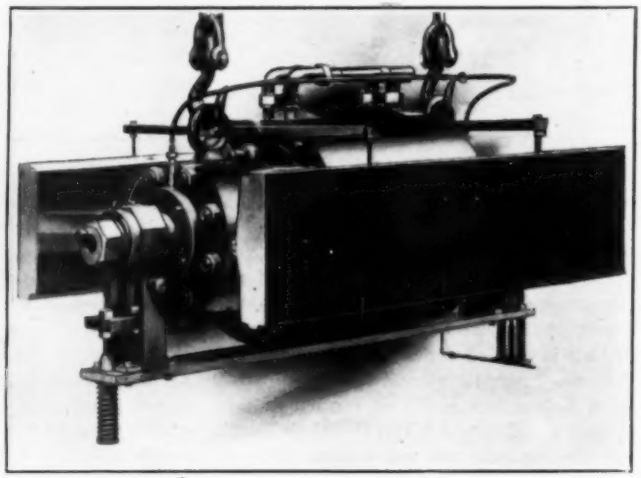


FIG. 5. THE MAIN PRESS COMPLETE

tached to it a rod 81 which extends out of the case and carries the pen for making the record.

For certain runs the dynamometer might be used with recording springs which would take their full 10-inch motion with a load on the drawbar of only 10,000 pounds, and, through some unexpected condition, the drawbar might receive a load greatly in excess of the 10,000 pounds, so that some stops should be provided to limit the motion of the springs. Furthermore, through inadvertence or carelessness, the throttling valve might be left open and the dynamometer receive a sudden load, with no recording springs inserted, and, under these circumstances, the piston, truck, etc., would jump ahead very suddenly, and solid stops are therefore inadmissible. The stops provided consist of eight stiff springs 91 arranged around the rear end of the recording cylinder, with stems 97 extending inward through the rear plate of the truck, the stems being provided with heads which receive the load from this plate after it has traversed 10 inches. These springs are assembled with a heavy initial load and are capable of stopping all the moving parts without shock.

Some of the Difficulties of the Work

Some of the mechanical difficulties encountered in the construction of this dynamometer, and the expedients resorted to in overcoming them, may be of interest.

At the very outset the question was raised as to the friction of a close-fitting but unpacked piston, subjected to hydraulic pressure, and some crude experiments were made with a Crosby gage tester, which led to the conclusion that under certain conditions this friction might be greater than would be allowable.

To investigate this question, an apparatus was designed which afterward became the recording cylinder, pistons, etc., of the dynamometer. The cylinder was provided with two holes through its side, midway of its length, so that the space between the pistons could be filled with oil, and the friction of the pistons then measured with various pressures on the oil. As both pistons have the same diameter, the pressure on the oil would not cause any unbalanced thrust, tending to move them in the cylinder.

The cylinder was bored and lapped, and then mounted in a framework, and an hydraulic accumulator was connected with the space between the pistons, and the friction measured with various amounts of pressure on the oil. The first experiments were made with plain, smooth pistons, having a nominal clearance of about 0.002 inch, and the results were as unexpected in degree as they were unsatisfactory, and were roughly as follows:

For a pressure of 10 pounds per square inch or less, on the liquid, the friction was 1 to 2 pounds, but when the hydraulic pressure was increased to 60 pounds, the friction was increased to nearly 20 or 30 pounds; although, after the pistons were started in motion, the friction was greatly reduced, as long as they were kept moving. When the pressure was further increased to 225 pounds, it was necessary to use a hammer to start the pistons at all, and after starting, the friction was some 40 or 50 pounds.

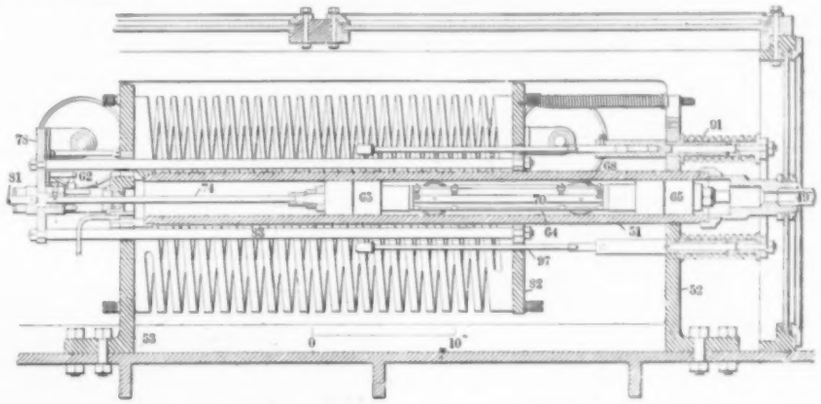


FIG. 6. RECORDING CYLINDER AND SPRINGS

it was so true that careful star gaging from end to end failed to show any variation in diameter; when the truck and pistons were placed in it, they ran very smoothly from end to end, with a slight amount of friction. The cylinder was

A long series of experiments was then made to determine the cause of this undue friction, and in making them it was found that the diameter of the cylinder varied, although the amount was so slight that it could not be found with a star

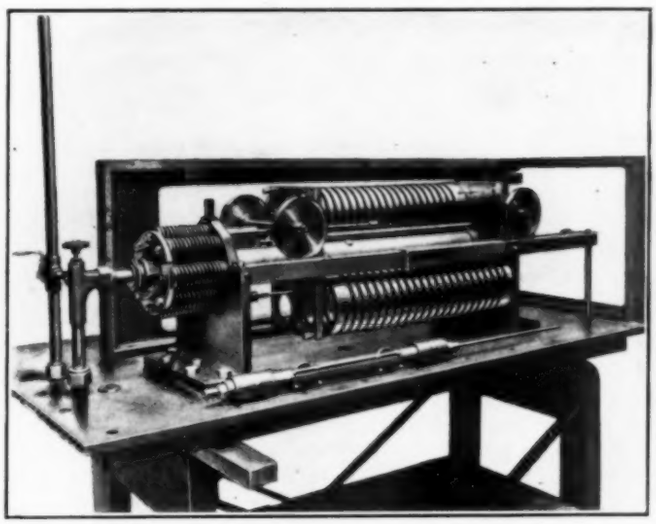


FIG. 7. THE RECORDING CYLINDER, SHOWING THE GROOVED PISTONS

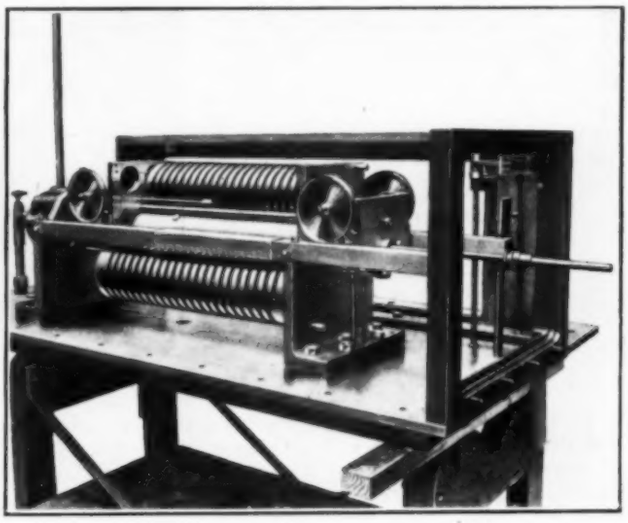


FIG. 8. THE RECORDING CYLINDER, SHOWING THE PEN ROD

gage. In order to ascertain at what points the diameter was smaller than the average, the pistons were placed at a certain point and the amount of leakage of oil by them, under a constant head, for a certain length of time was measured. They were moved 2 inches and the amount of leakage measured at that point, and so on. In this way some idea could be obtained of where the cylinder needed more lapping.

This lapping was done by using a lead

lap, rouge and oil, and then cleaning the cylinder very clean with gasolene; after this lapping had been done, pistons were made with various amounts of clearance and also with series of grooves, and it was found that the greater number of grooves the less the friction, but, unfortunately, the greater the leakage. No matter how closely the pistons were fitted, even if the difference in diameters was only 0.0002 inch or 0.0003 inch, when the pistons were at rest, the opening on one side would be greater than that on the other, which allowed the liquid under pressure to flow into the open side and hold the pistons tightly against the opposite wall of the cylinder, preventing the flow of the liquid on that side, and so causing a large, unbalanced side load on the piston, which produced friction.

At times, by some good luck, when the pistons were moving, the liquid would completely surround them and they would move without any sticking, but these occasions were rare. To allow the liquid to surround the pistons a spiral groove was tried, and it was found that the friction became small and did not increase as the hydraulic pressure increased, so that the whole difficulty was very easily overcome by the simple expedient of cutting a fine spiral groove on the exterior of the pistons. This of course increased the leakage; but, as the groove is V-shaped, about 0.015 inch wide at the top and 0.01 inch deep, its section is very small. The diameter of the pistons is 2 17/32 inches and their length 2 inches; as the pitch of the groove is 0.1 inch, its length is 11 feet on each of the four pistons. The leakage through a pipe of this size and length is very small.

The main press also presented several difficult problems, the principal one being to get the two half-cylinders 20 (see Fig. 2), piston 17, piston rod 16 and the holes in the bushings 25 and 26 in the half-cylinders and the housing, all exactly in line and all so perfectly true that there would be very little friction, and, at the same time, very little leakage.

The hole in the housing was bored first, and then the housing planed to the boring, in order to get the sides perfectly parallel with the hole. The piston rod and sleeve 18 were finished by grinding and then lapped with a lead lap with both ground glass and crocus powder for several days, until it was reduced to the required size and to uniform diameter. The piston 17 was turned nearly to size, and then ground, but as the works was not provided with a grinding machine capable of grinding so large a diameter (16¼ inches) a grinding apparatus was rigged up on a lathe. When started it was found that each tooth in the back gear caused a slight variation, which could be seen on the surface of the piston, after grinding. It was therefore necessary to rig up and turn the piston by hand on dead centers. The surface of this piston is also provided with a spiral groove to prevent sticking under pressure. This groove is in the form of a quadruple thread.

After rough turning, boring and drilling the half-cylinders, each was very carefully strapped on a face plate, the holes for the piston-rod bushing very carefully turned to size, the hole for the piston turned nearly to size, then ground, and finely lapped with a lead lap and ground glass until the piston would just drop in by its own weight. A false piston rod and a narrow cast-iron piston were then made, this piston being provided with a lead rim, which was charged with ground glass; the two half-cylinders were assembled with a false piston and piston rod in place, the cylinders placed on the table of a boring mill, and the piston rod fastened to the tool post. In this manner the cylinders were very slightly lapped after being assembled.

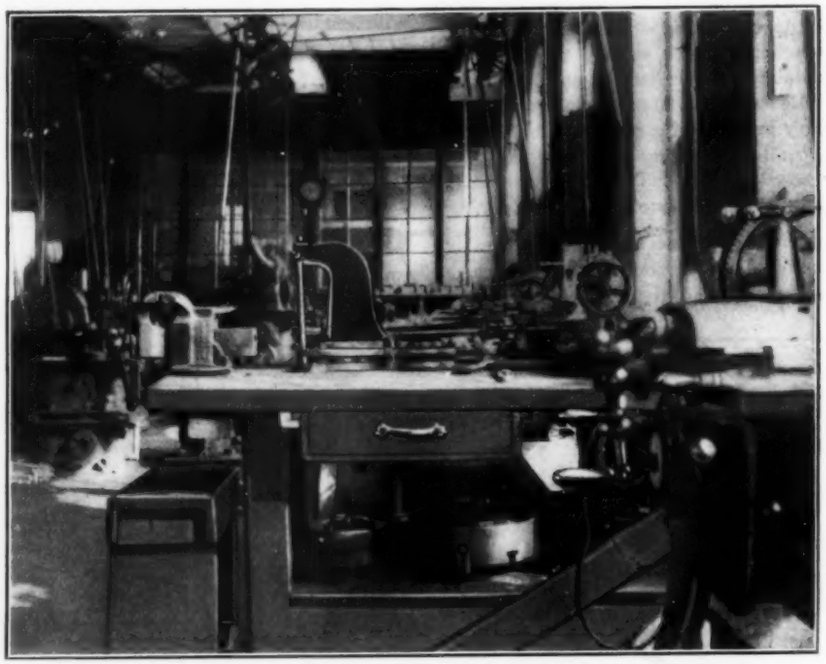
The four bronze bushings were turned and were made force fits, but the holes in them were left slightly smaller than the piston rod. The first idea was to lap the holes in these four bushings after assembling them in place, but, after some experimenting, it was found to be impracticable to get satisfactory results in this way. The method finally used was as follows:

An end reamer was made, the hole in which very nicely fitted the small part of the piston rod, while its exterior was exactly the size of the large part of the piston rod. One of the bushings 25 was then forced into one of the half-cylinders and the two half-cylinders assembled with the piston and piston rod, with the reamer in the cylinder, on the piston rod, between the piston and the bushing. The weight of the piston rod was carried in a sling, and the rod was such a good fit in the piston, and the piston in the cylinder, that by rotating the reamer on the rod, the bushing was reamed exactly to size and in line with the cylinder. The apparatus was then disassembled, the other inner bushing 25 forced into its place, the parts reassembled and this bushing reamed in the same manner. Then the two half-cylinders, piston, etc., were assembled with the housing 11, the reamer slipped into one of the bushings already finished, the outer bushing 26 on that side slipped into place, the piston rod inserted, and that bushing reamed. The last bushing was reamed in the same manner.

Location of Shop Benches

By I. B. Rich

The first shop, wherever it was or whoever designed it, had the benches running along the wall, and across the windows. The vise was fastened to the bench in front of the window, so that the light would be thrown on the work, and so that any stray chunks of metal that might be chipped off by the strenuous machinist would fly out of doors instead of against the wall. If the window happened to be shut, the piece of metal left its mark to prove that it was not in the shop.



LOCATION OF BENCHES IN THE FORBES SHOP

In the dark spots in between the windows, tools went astray, and an accumulation of junk of various kinds was wont to collect with amazing regularity.

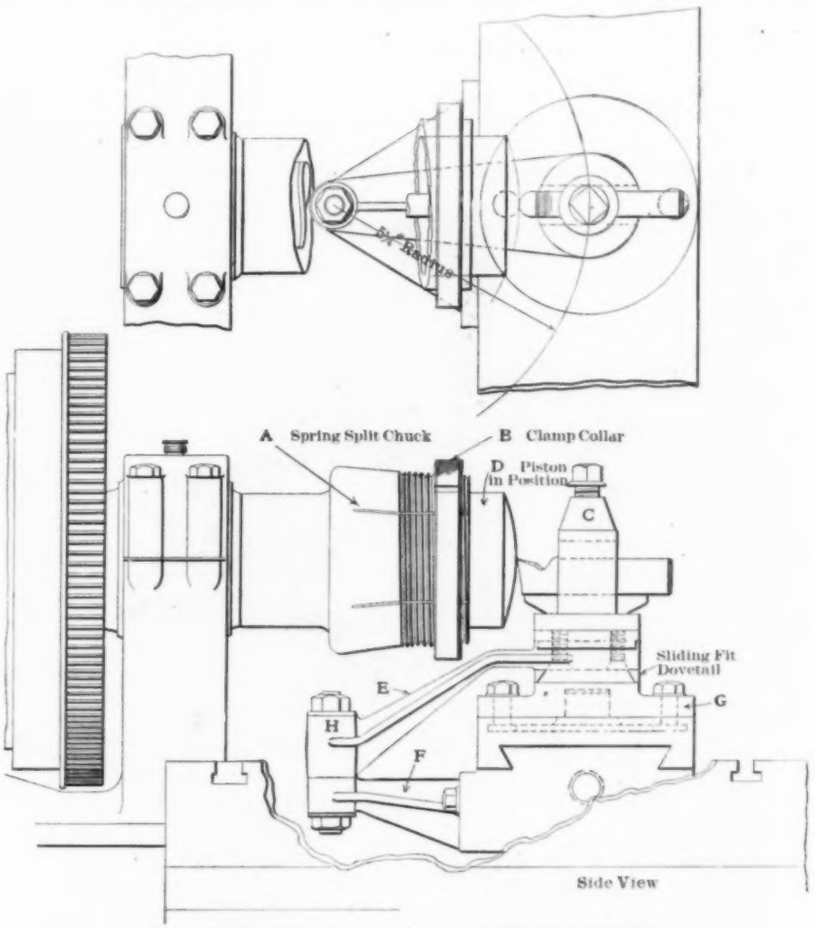
The lathes or other machines were lined along parallel with the benches, so the machinist could turn around and work at the vise while the lathe was in a long cut, and it also made a good place for him to lean against when stools were not allowed.

Incidentally he stood in his own light, and burned much oil or gas, and strained his eyes. The boss paid for the gas only.

The next step was to move the lathes nearer the window, and to put the benches behind them—usually between two rows of machines. This gave the lathes better light, but the men still made their own shadow on the work.

The placing of lathes with their tail ends next the window was a longed-for but impractical solution, on account of the line shaft and the nuisance of quarter-turn belts. The individual or small-group motor drive makes this possible.

But it remained for someone with the nerve to get out of the rut to make a radical change in the bench proposition, and the first real smashing of old ideas in this line that I ever saw was in the Forbes shop, in Hoboken, about 12 years ago. Whether he was the pioneer, the real Columbus of the situation or not, I don't know.



ROUNDING THE HEADS OF PISTONS FOR AUTOMOBILE ENGINES

The photograph shows just how these benches are arranged. The lathes back up against the windows, which are large and high. The benches butt into the wall between them and get very good light indeed, even next to the wall.

The vise is at the end of the bench, as shown, and one has a small Greenerd arbor press in place of the vise. Drawers are handy for the lathe man, and he gets better light than in most cases, though he has the light in his eyes and an eye-shade may be a necessity.

Of course, this is a case where the bench is an auxiliary to the lathe, and the arrangement might not go at all where much bench work was done. But it has many advantages for such a case as this, and deserves to be better known.

Lathe Fixture for Rounding the Head of the Automobile Piston

By Albert A. Dowd

I recently had about twelve thousand pistons for gasolene automobile engines to machine, and all the operations went smoothly and economically enough, with the exception of rounding the head to a 5¼-inch radius.

We had been doing them on a lathe, rigged up especially for the work, with a former of the required radius in the tailstock. By means of weights, etc., a roller placed on the carriage was forced back against this former, and the tool fed across the end of the piston, being forced to make the desired cut by the shape of the former.

This job required one man's entire time, and he had to be very particular to keep his weight on the carriage, to throw it back against the former all the time.

I tried to think of some better method of doing it, and finally hit on the way shown by the sketches.

I took an old lathe which had a compound rest on it, and stripped it down to the cross slide. I bolted a bracket *F* in the sketch, on to the carriage, and hung a radius arm *E* from a shouldered stud in the bracket.

This radius arm was dovetailed, so that it slid freely on the revolving base *G*, which I made especially to take the place of the swivel base of the compound rest. The dovetail breaking through the round surface makes it look as though this dovetail ran parallel to that of the cross slide, but in reality it runs in the opposite direction. If the sketch were shaded it would show the extension of arm *E*, sliding across the round base.

On top of this radius arm I securely fastened the tool post and base *C*, by means of two 7/16-inch screws. I then made a spring split chuck *A*, with a clamp collar *B* slotted to receive a spanner wrench. Inside of this chuck was a ⅝-inch stud, not shown, running up far enough to strike the edge of the boss on the inside of the piston and act as a driver. I made a special gage to set the tool to the proper radius from the center *H*, after grinding.

I also made suitable stops on the ways, so that I could bring the carriage up to the same distance every time I put in a new piston, and clamp it securely.

It will be readily seen then that all a man has to do is to draw back his cross slide to the proper point, and after making his adjustments, simply throw in his cross feed. He is then free to attend to another machine for about two minutes, when the piston will be finished.

As I had another lathe right behind the man, rigged up especially with a two-jawed chuck for rough turning the outside of the piston, this man could attend to both machines, and it would just keep him comfortably busy, incidentally turning out about twice as much work on each job as before, and in this way practically doing the work of about two men.

Mining Respirators

Reported successful experiments have been conducted in a Yorkshire mine with two kinds of artificial breathing apparatus to enable rescuers to work in irrespirable air after an explosion. A portion of the mine had been provided with the conditions existing after an explosion. Four men were equipped with the contrivances and remained in the place several hours engaged in such work as would be necessary after an explosion. It is believed that these devices would enable a corps of trained men to enter a mine filled with foul air, to restore the ventilation, and to save many lives.

Machinery and Tools for a Seamless Drawn Steel Bath Tub

The operations and product of a job of drawing or deep stamping, which the makers assure us is the largest yet produced in this country by the toggle-press method, is illustrated in the accompanying cuts, together with the machinery and tools. The drawing is done cold in three operations. There is only one intermediate annealing process. This is necessary to restore ductility to the rim to avoid any possibility of fracture in the third or rim-rolling operation.

The plate is a plain squared sheet of mild steel ⅛ inch thick. The product of the first operation is shown by Fig. 1. The product of the second is shown in Fig. 2. This is a completed tub as far as the drawing is concerned. In Fig. 3 we see the tub finished as far as the metal working goes, except the punching of small holes for the supply and waste pipes.

The time required for the three operations is not over three minutes.

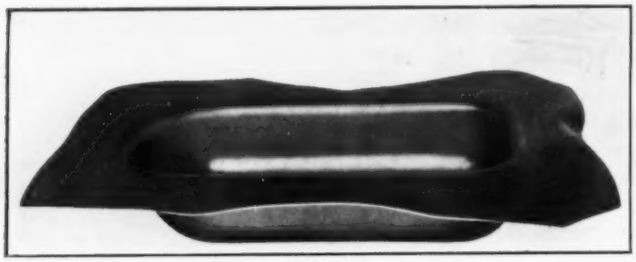


FIG. 1. PRODUCT OF FIRST OPERATION

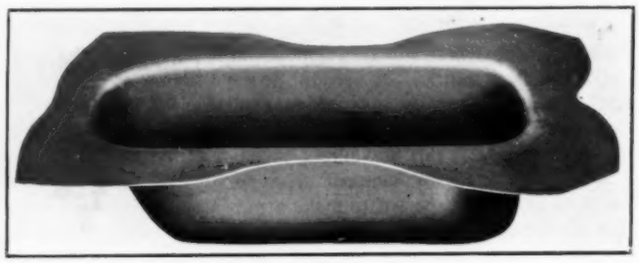


FIG. 2. PRODUCT OF SECOND OPERATION

The Drawing Press

In Fig. 4 we see the drawing press.

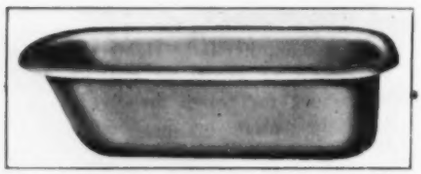


FIG. 3. PRODUCT OF FINAL OPERATION

This machine is fitted with two steam cylinders distinctly separate in their functions. The smaller is located on the right hand and operates and controls the blank holder.

The blank holder has a vertical motion of 19 inches, and is actuated by four toggles, one at each corner. Their combined pressure is estimated to be 1400 tons. The toggles are connected in pairs to two horizontal shafts running from right to left, one on the front and the other on the rear of the press. These shafts are connected outside of the housings at the right-hand end to the piston rod by means of bell cranks and links. The control of this blank holder is independent of the other movements of the machine.

The main steam cylinder which operates the forming plunger is 28 inches in diameter. Its piston stroke is 50 inches. The piston rod is attached to a steel crosshead which weighs 6000 pounds. To this is keyed the forming punch, which with the crosshead gives a falling weight of about 20,000 pounds.

The base or anvil is made in three sections, having a combined weight of 90,000 pounds. The main arch, the cylinder, and the housings or uprights are bolted together on the base, and are strengthened by four rods passing through all of these members. These rods are shrunk into position. Some of the general dimensions of this press are: width between housings 96 inches, bed 60x96 inches, extreme hight, 23 feet, and total weight, 260,000 pounds.

The Drawing Dies

The drawing dies and attachments were designed to give the metal the greatest protection possible, to avoid the forming

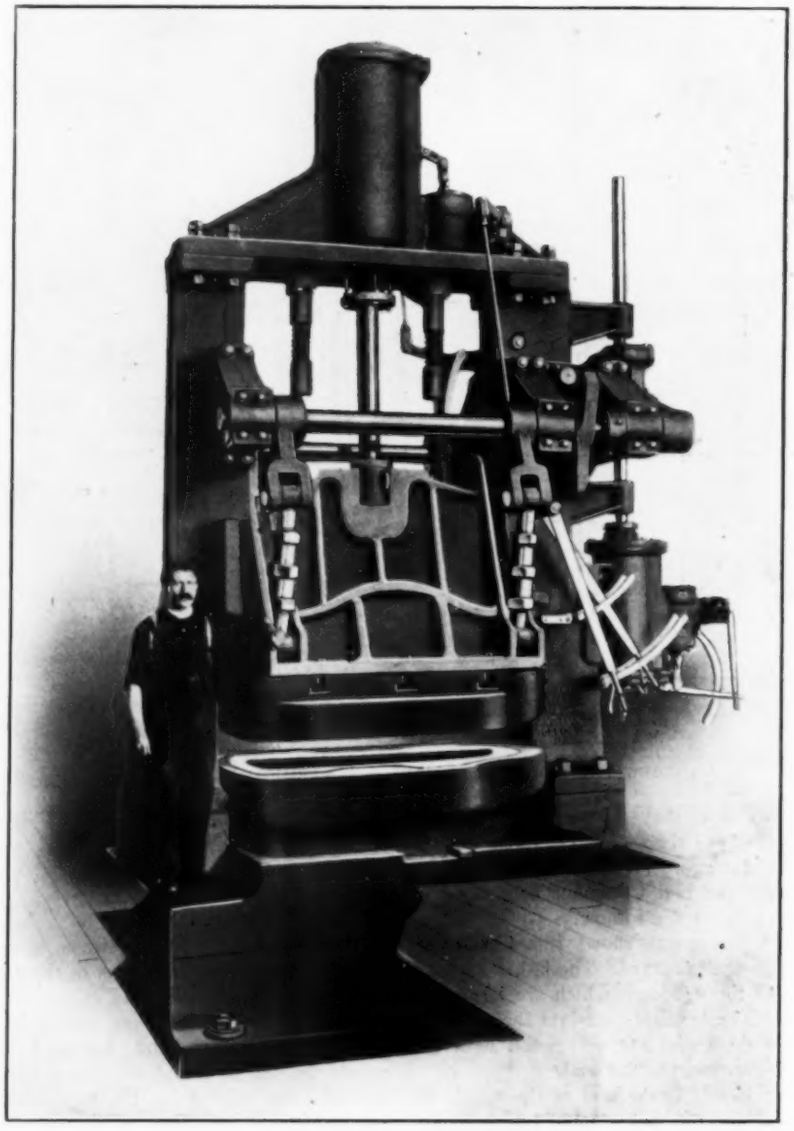


FIG. 4. THE DRAWING PRESS

of wrinkles or buckles in the sheets. The results are such that no spinning or ironing process is necessary as a finish. The drawing die is adjustable and serves for three lengths of tubs. A separate punch, however, is required for each length. The lower die is fitted with an automatic

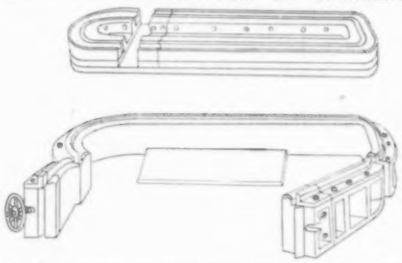


FIG. 6. DIE FOR TRIMMING AND FORMING RIM

knock-out operated from the blank holder, for ejecting the work when the operation is finished.

THE TRIMMING PRESS

The half-tone Fig. 5, shows the double back-geared power press used for trimming and rolling the rim. It is fitted with a die holder or fixture, which has its front section hinged and made to open—see Fig. 6. The swinging section is provided with a positive locking device.

The press slide is fitted with a positive automatic knock-out, passing through the punch. As the slide lifts with the stroke of the press, this knock-out is brought into action, stripping the work from the punch. The bed is also fitted with an automatic knock-out, cam actuated, which is timed to rise with the slide. The cam is on the left-hand end of the crank. This knock-out device receives the work when it is forced off by the knock-out in the slide, and prevents it from falling back into the die.

Some of the dimensions of this press—which the makers designate as 84-inch No. 96 double-geared special—are: stroke 6 inches, width between uprights 86 inches, bed 48x84 inches, and total weight about 85,000 pounds.

THE OPERATIONS

In the first drawing operation the attendant places the sheet in position in the die, and by means of the small cylinder brings the blank holder and pressure plate to bear with the necessary pressure. The large cylinder then forces down the forming punch and draws the sheet to a partially formed tub 12½ inches deep. This should not require more than one and one-half minutes to complete.

The blank is then annealed and pickled to remove the scale, and is ready for the second operation. This is similar to the first, except that the tub is drawn to its full depth, 17½ inches. This operation is shorter in point of time than the first.

The third operation in the power trimming press trims and rolls the rim at one stroke. The time required is less than one and one-fourth minutes. In actual use 48 tubs have been rolled and trimmed in an hour.

The complete equipment was designed and built by the Toledo Machine and Tool Company, of Toledo, Ohio.

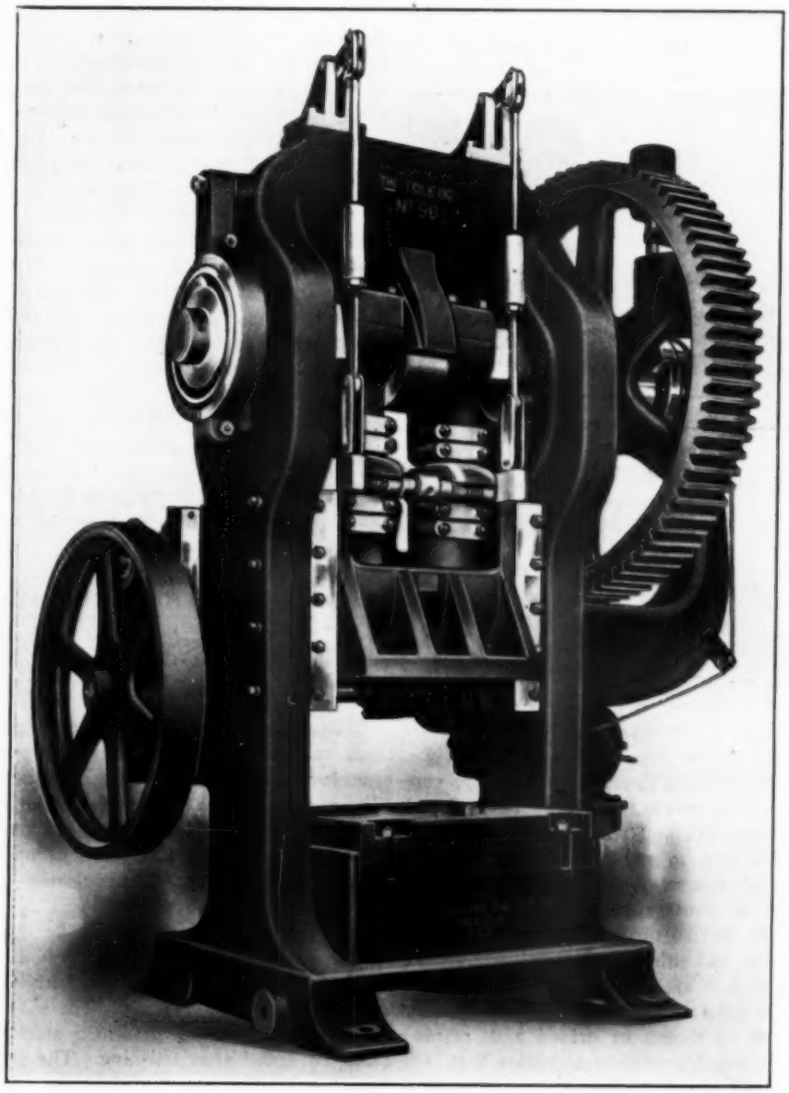


FIG. 5. THE TRIMMING PRESS

Tapping Shallow Holes—Making a Saw Blade from a Clock Spring

For tapping a very shallow hole the following method is described by *The Indian Textile Journal:* It is assumed that the depth of the hole is equal to one diameter. Clamp a piece of similar metal about one diameter in thickness, over the location of the proposed hole; drill through this and one diameter beyond with a tapping drill, then tap the hole in the usual way, taking great care in removing the cuttings, so that the plug tap can go clear to the bottom. The guide piece may now be removed, and may be used on other holes if so desired. Holes may be tapped to a depth of only one-half the diameter of the screw with a clean and full thread.

To make a fine-toothed saw blade out of a piece of clock spring, use a very fine triangular file with a side not more than one-quarter inch; grind one side of the file quite smooth and polish it slightly on the whetstone. Supposing that 1/20-inch pitch is desired, take a piece of steel or iron wire of about this size and double it into a loop, leaving a space of 1/16 inch between the sides; hold it in the left hand, and the file, by means of a well fitted handle, in the right. The saw blade is let into a piece of wood so as to project 1/16 inch all along, and the block is held in the vise. The first tooth is filed as near as possible to correct size, at the end of the blade, and the wire loop is then inserted into the notch and used as a gage against which the polished side of the file is laid, and the next tooth is cut. If the pitch be found too great, thin the wire a little. Rough out all the teeth, reverse the blade in the vise and complete them from the other side.

Unless something special is wanted, it is usually better to buy a blade.

Standardization of Special Tools

A Few Standard Types of Drilling Jigs and Standard Small Parts for Jigs and Fixtures, as Screws, Bushings and Straps

BY M. E. ELLIS

The controlling reasons for making jigs and fixtures are so well known that it is unnecessary to mention them. Some of the important features of designing these special tools are, however, not so well appreciated.

Such a special tool must not only have all of the necessary elements of accuracy but must be quick in manipulation. Too often a designer seems completely to ignore this point, when a very slight modification in holding the work would increase the production enormously.

A tool designer should be intimately acquainted with the machine-tool equipment on which the special tools are to be used. This determines to a considerable extent the sequence of individual operations.

In many factories using a large number of jigs and fixtures special small tools, such as cutters, drills, reamers, taps, counterbores, etc., can be and often are standardized. This point should not be neglected, as it results in a direct and immediate economy.

Still another feature which lends itself to standardization is in the design of jigs and fixtures, and their small parts. At first thought it may seem paradoxical to standardize such special tools, where usually only one is ever made from a particular design.

However, such standardization is possible to quite an extent, and to a real advantage provided a large amount of tool work is carried on. For instance, a system of drill, reamer and tap bushings, both loose and fixed, can be determined upon. Screws for jigs and fixtures can be systematically designed for kind and size. Straps, or, at least, strap blanks, can be standardized, and carried in stock. Setting spots on milling and planing fixtures can be designed to use a very few standard setting blocks, except for formed work. Again, jig and fixture castings can be classified into types and styles, and these brought to standards to a certain extent.

In this article I will take up the standardization of small drilling jigs and show a few styles of jigs and their parts, which I have used.

Drilling Jigs

In the manufacture of duplicate parts, drilling jigs is one of the greatest factors in economy and accuracy. Whether the operations to be performed are simple or complicated, the drilling jig is an indispensable tool, and in no other operation can jigs or fixtures be used to better advantages than on the drill press.

The much argued question as to whether we should drill before milling or mill before drilling has never yet been answered to the satisfaction of everyone, and in all probability it never will be. While some are firmly convinced that we should drill first, others are just as firmly convinced that the best results can be obtained by reversing the operations. Regardless of all discussion, there are certain fixed mechanical ideas that should be respected, and while one part can be drilled first to the best advantage, it is just as necessary to reverse the operations on another part, while still others can be carried through with equally good results by either order of operations. Some parts are of such an irregular shape that a positive location cannot be obtained except by means of drilled and reamed holes, which necessitates drilling first. On the other hand, with properly constructed jigs, there is less chance for error when locating from a planed, milled or ground surface. It has been proved that in many instances the parts can be located in the jigs and drilled from the planing or milling with a greater degree of accuracy than they can be planed or milled from the drilled holes. Again, the error in setting the tool or cutter is apt to be greater than in locating the part in the jig.

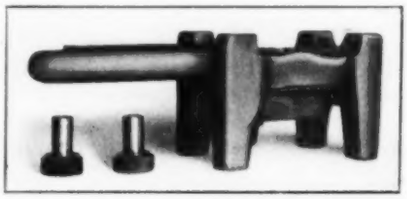


FIG. 1. STANDARD TYPE OF OPEN JIG

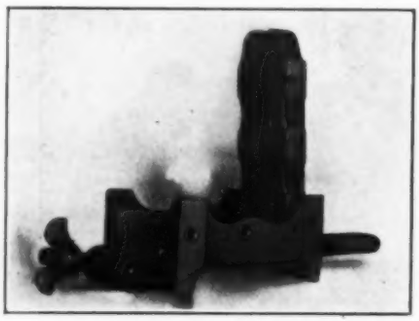


FIG. 2. STANDARD TYPE OF BOX JIG

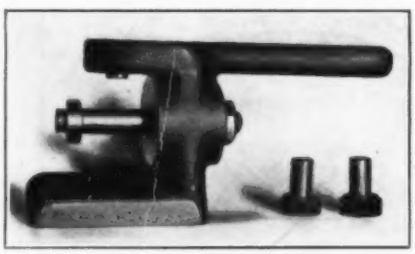


FIG. 3. ANOTHER STANDARD TYPE

There are many good points in each argument, but the shape of the part and the nature of the operations must determine the order of the operations.

There are several styles of jigs to be considered in taking up the question of standardizing, each one of which is especially adapted to some particular class of work.

After these styles are selected, castings for a few standard sizes of each style can be made and carried in stock. From these castings jigs can be easily and cheaply made which will meet the requirements of a great many small parts. A few standard sizes of the different styles of straps which are most commonly used can be made and carried in stock. Blanks for bushings of various styles and sizes can be made to be finished as required. Screws which are commonly used for jig purposes can easily be standarized. This system will allow the different parts to be cheaply made in quantities and on a manufacturing basis.

The Open Jig

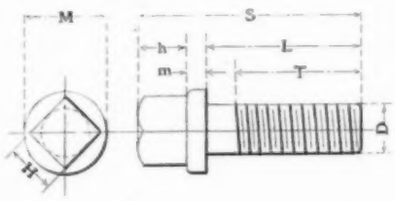
One of the most common types of jigs in general use and one that is adapted to a great many parts is the *open jig*, Fig. 1. Some convenient sizes to carry in stock are as follows:

Width of Body.	Length of Body.	Hight of Base.
2 in.	3 in.	2 in.
3 in.	4½ in.	3 in.
4 in.	6 in.	4 in.
6 in.	9 in.	6 in.

Seats can be planed in the castings to suit each particular part; or, if a large number of parts are to be produced in a jig, it may receive a hardened-steel seat. Stops, screws and straps can be placed where needed, and steel bushings or linings can be inserted. These castings will be found very convenient in making jigs for small parts which are to be drilled from one surface only.

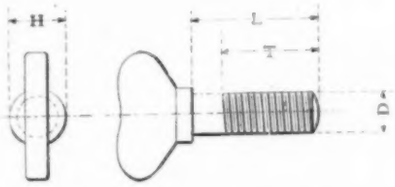
A convenient strap to use with these jigs is shown in Fig. 14. These straps should be made of bessemer steel and case-hardened after finishing. The slot *G* for the binding screw should not be cut until the strap is selected for use. It can then be located in the proper position

and made of such dimensions as to allow the strap to be slipped back out of the way when work is being placed in and taken from the jig.



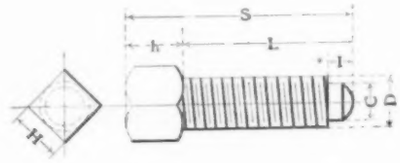
D	Thrd.	L	T	h	m	H	M	S
1/4	Shop Standard	1	3/4	1/4	4/32	1/4	7/16	1 11/32
5/16		1	3/4	5/16	1/8	5/16	1/2	1 7/16
3/8		1 1/2	1	3/8	1/8	3/8	5/8	2
7/16		2	1 1/2	7/16	3/16	7/16	11/16	2 5/8
1/2		2	1 1/2	1/2	3/16	1/2	13/16	2 11/16

FIG. 4. COLLAR-HEAD JIG SCREWS



D	Thrd.	H	L	T
1/4	Shop Standard	3/8	1	3/4
5/16		7/16	1	3/4
3/8		1/2	1 1/2	1

FIG. 5. WINGED JIG SCREWS

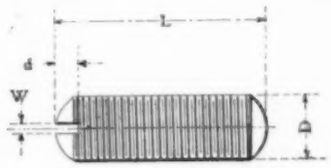


D	Thrd.	L	h	I	C	H	S
1/4	Shop Standard	1	1/4	1/8	5/32	1/4	1 1/4
5/16		1	5/16	1/8	15/64	5/16	1 5/16
3/8		1 1/2	3/8	1/8	17/64	3/8	1 7/8
7/16		1 1/2	7/16	3/16	5/16	7/16	1 15/16
1/2		1 1/2	1/2	3/16	11/32	1/2	2

FIG. 6. SQUARE-HEAD JIG SCREWS

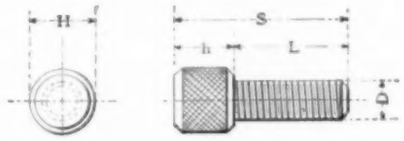
The Box Jig

Another type of jig in common use is the *box jig*. This jig is generally used when holes are to be drilled in two or more sides of the work. Work may be held in these jigs by means of straps and



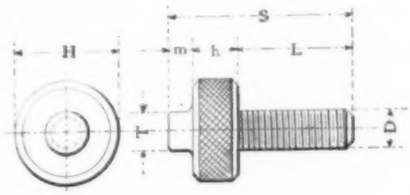
D	Thrd.	L	W	d
3/16	Shop Standard	1/2	.032	1/16
1/4		3/4	.040	3/32
5/16		1	.057	3/32
3/8		1	1/16	1/8
7/16		1 1/2	5/64	1/8
1/2		1 1/2	5/64	1/8

FIG. 7. HEADLESS JIG SCREWS



D	Thrd.	L	h	S	H
1/4	Shop Standard	3/4	3/8	1 1/8	1/2
5/16		1	1/2	1 1/2	9/16
3/8		1	9/16	1 9/16	5/8

FIG. 8. NURLED-HEAD JIG SCREWS

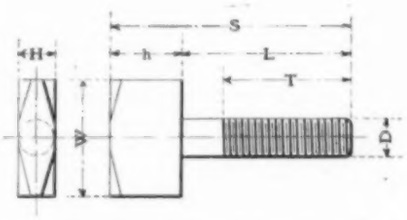


D	Thrd.	L	h	m	S	H	T
1/4	Shop Standard	3/4	5/16	5/16	1 1/4	3/4	1/4
5/16		1	7/8	7/32	1 19/32	7/8	5/16
3/8		1	7/16	1/4	1 11/16	1	3/8

FIG. 9. NURLED-HEAD JIG SCREWS

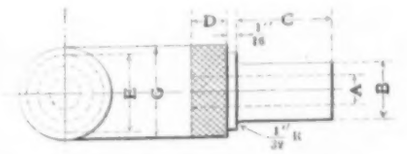
set-screws, or by hinge covers and set-screws, as the nature of the part requires Such a jig, with a hinge cover, is shown in Fig. 2. Castings of the same general sizes as for the *open jig* will be found convenient if carried in stock.

In Fig. 2 a hinge screw with a wing nut is used to clamp the hinge cover. When this is not convenient, a screw such as shown in Fig. 10 may be used with good results. This screw, when used,



D	Thrd.	H	h	L	S	T	W
5/16	Shop Standard	5/16	5/8	1 1/2	2 1/8	1 1/8	1 1/16
3/8		3/8	11/16	1 5/8	2 5/16	1 1/8	1 3/16
7/16		7/16	3/4	1 7/8	2 5/8	1 1/4	1 5/16
1/2		1/2	3/4	1 7/8	2 5/8	1 1/4	1 5/16

FIG. 10. LOCKING JIG SCREWS



A	B	C	D	E	G
No. 52	1/4	9/16	1/4	7/16	9/16
No. 30	5/16	5/8	1/4	1/2	5/8
No. 12	3/8	5/8	5/16	9/16	11/16
1/4	1/2	11/16	5/16	11/16	13/16
5/16	9/16	3/4	5/16	3/4	7/8
3/8	5/8	3/4	3/8	13/16	15/16
7/16	11/16	13/16	3/8	7/8	1
1/2	3/4	7/8	7/16	13/16	1 1/16
9/16	13/16	7/8	7/16	1	1 1/8
5/8	7/8	15/16	3/8	1 1/16	1 3/16
11/16	15/16	1	1/2	1 1/8	1 1/4
3/4	1 1/16	1	9/16	1 3/4	1 7/16
13/16	1 1/8	1 1/16	9/16	1 5/16	1 1/2
7/8	1 1/4	1 1/8	5/8	1 7/16	1 5/8
15/16	1 5/16	1 3/16	5/8	1 1/2	1 11/16
1	1 3/8	1 1/4	11/16	1 9/16	1 3/4

FIG. 11. LOOSE BUSHINGS FOR JIGS

should be adjusted so that only a quarter turn will be needed to clamp or release the cover, which should be slotted to admit the head of the screw.

Another Standard Jig

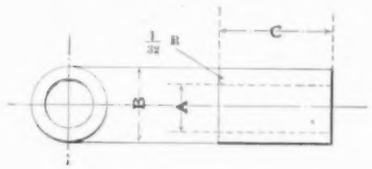
In Fig. 3 is shown another type of jig which is very useful in drilling set-screw

Size of Base.	Hight.
3 in. x 3 in.	3 in.
4 in. x 4 in.	4 in.
6 in. x 6 in.	6 in.

holes in collars, hubs of pulleys, gears, cams, etc. A jig of this description can often be used for several parts, when interchangeable studs and slip bushings can be made to suit each part. Convenient sizes for castings are shown in above table.

The overhanging arm for the bushings should be cast long and cut off to the required length. The work should be clamped by means of a split washer and set-screw in the end of the stud. Stops can be easily arranged to locate the work.

It is not to be understood that a standard stock of castings can be carried that will meet a majority of requirements, but if some are carried, it will be surprising to find the number of parts for which they can be adapted.



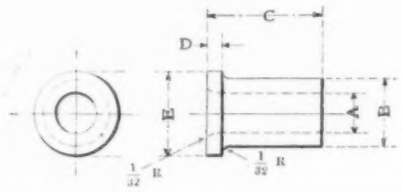
A	B	C
32	1/4	5/16
30	5/16	9/16
12	3/8	9/16
1/4	7/16	9/16
5/16	1/2	5/8
3/8	9/16	5/8
7/16	5/8	5/8
1/2	11/16	11/16
9/16	3/4	3/4
5/8	7/8	3/4
11/16	15/16	13/16
3/4	1	7/8
13/16	1 1/16	7/8
7/8	1 1/8	15/16
15/16	1 3/16	1
1	1 1/4	1

FIG. 12. FIXED BUSHINGS FOR JIGS

Binding Screws

Binding screws should be made in various sizes and with threads to conform to the standard taps with which the shop is provided. When drills of a very large size are used, a screw with a square or hexagon head is best, as the work requires firm clamping. If the drills used are small, a winged screw will be sufficient and more convenient, as it will require less time to manipulate. Some good screws for clamping straps are shown in Figs. 4 and 5. General standard dimensions are given. Of course screws can be made of any length desired.

When the work is to be held against the seat or a stop by means of a set-screw, such screws as shown in Figs. 6 and 7 will be found very useful. General dimensions are also given. If, however, the work is very light, a wing screw can be used.



A	B	C	D	E
1/4	7/16	11/16	3/32	9/16
5/16	1/2	3/4	3/32	5/8
3/8	9/16	13/16	3/32	11/16
7/16	5/8	13/16	3/32	3/4
1/2	11/16	7/8	3/32	13/16
9/16	3/4	15/16	1/8	7/8
5/8	7/8	1	1/8	1 1/16
11/16	15/16	1 1/16	1/8	1 1/8
3/4	1	1 1/8	1/8	1 3/16
13/16	1 1/16	1 3/16	1/8	1 1/4
7/8	1 1/8	1 1/4	5/32	1 5/16
15/16	1 3/16	1 5/16	5/32	1 3/8
1	1 1/4	1 5/16	5/32	1 7/16

FIG. 13. FIXED BUSHINGS FOR JIGS

Supporting Screws

Figs. 8 and 9 show screws that are very useful in supporting work against the thrust of drills when the work is of such a nature that it cannot be supported otherwise.

Locking Screw

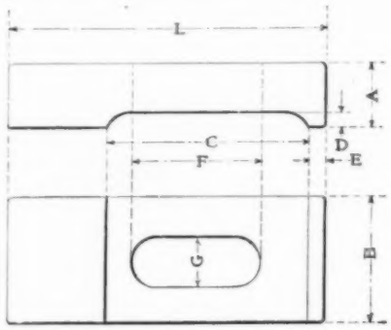
A convenient hinge-cover locking screw is shown in Fig. 10, together with standard dimensions.

The different sizes of the styles of screws shown are not only used with drilling jigs, but are equally useful with other jigs and fixtures. These screws should be made of screw stock and case-hardened.

Bushings

When drilling and reaming operations are to be performed in the same jig, two slip bushings, one for the drill and the other for the reamer, should be used; if the jig is to be used for a large number of parts, the hole for the bushings should in turn be bushed with a steel lining to prevent wearing. The soft cast iron will wear rapidly if this is not done, and the jig will soon have to be rebound and rebushed.

Three different styles of bushings and dimensions are shown in Figs. 11, 12 and 13. These can be blanked out on screw machines and finished to required sizes as needed, and should be made of tool steel. Allowances should be made in the blanks for grinding and lapping after hardening. Fig. 11 shows a slip bushing; Fig. 12 shows a stationary bushing, and Fig. 13 shows a stationary bushing where tools with stop collars are to be used. Such bushings as shown in Figs. 12 and 13 are also used for linings for slip bushings.



A	B	C	D	E	L
1/2	1	1 3/8	1/8	1/8	2 1/2
1/2	1	1 5/8	1/8	1/8	3
5/8	1 1/4	2	1/8	3/16	3 1/2
5/8	1 1/4	2	1/8	3/16	3 1/2
5/8	1 1/4	2	1/8	3/16	4

FIG. 14. JIG STRAPS

Straps

A standard strap is shown by Fig. 14. A table of dimensions is also given, omitting *G* and *F*, which have to be determined for each particular case.

The standards which I have described for jigs and jig parts have been used in my practice with good results, and the broad principle of such standardization is one that can well receive attention in a shop doing a large amount of tool work.

Punching- and Shearing-machine Frame Calculations

By Lucigen

In determining the strength of punch and shear frames there appears to be much uncertainty as to the best method of procedure. The frame is sometimes designed far too strong for its requirements, with a consequent waste of metal. In other cases it is made too weak and soon has to be consigned to the scrap heap. In this article I will show a method which I have adopted to calculate the stresses in such a frame.

Calculations for Pressure

It is first necessary to know the maximum pressure to which the machine will be subjected. Take the case of punching a 15/16-inch round hole through a ¾-inch plate: The diameter of the hole in the die will be about ⅛ inch larger than the punch, or 1 1/16 inches. The mean of these two diameters is 1 inch. Therefore the area in shear will be $1 \times 3.142 \times \frac{3}{4} = 2.36$ square inches. In punching, the pressure required is taken as 30 tons per square inch. Thus the pressure to punch the hole will be $30 \times 2.36 = 70.8$ tons.

The pressure required to shear a plate is found as follows: Assume the plate to be ¾ inch thick, and the slope of the shear blade to be 1 in 10. It is assumed that a plate is sheared when the blade has passed through one-third of the thickness. For a ¾-inch plate the penetration is therefore ¼ inch. The maximum area in shear at any time is that shown by the shaded portion in Fig. 1. A slope of 1 in 10 is ¼ inch in 2½ inches, so that the area in shear is $2\frac{1}{2} \times \frac{3}{4}$ inch $= 1.875$ square inches. An average shearing pressure of 27 tons per square inch gives a total pressure of $27 \times 1.875 = 50.6$ tons.

A short time ago I noticed an article in which the writer took only half this area in his calculations, thus subjecting the machine to double the calculated load. Whether the frame broke or not was not stated.

Calculations for Strength

Having found the greatest load which the frame has to withstand, it now becomes necessary to determine a suitable section. After fixing on a section, by taking advantage of experience with previous machines, calculations must be made to see if it has the necessary strength. If not, another must be tried until the most economical section is obtained.

The use of complicated formulas often leads to mistakes unless one is well acquainted with them. It is much better to work from first principles. With a beam having a concentrated load at one end the maximum stress f in tons per square inch due to bending $= \frac{Mh}{I}$ where M is the bending moment in inch tons, h, the distance in inches from the neutral axis to the outside fiber, and I the moment of inertia of the section. In the case of the section at the waist of a punching or shearing machine there is also an equally distributed tensile stress per square inch equal to the load divided by the area of the section, or $\frac{P}{A}$. This must be added to the tensile stress due to bending, and taken from the compressive stress.

A graphical method of obtaining the moment of inertia is sometimes employed, but the labor involved is excessive, and the liability of error great. I saw it used recently, and the result showed an error of 10 per cent. in the stress. It is quicker

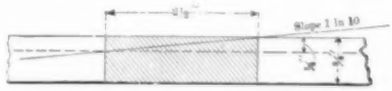


FIG. 1. A PLATE IN SHEAR

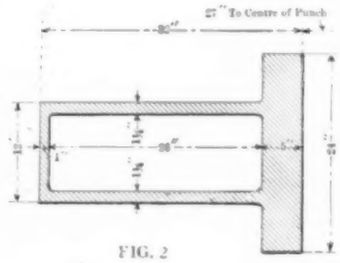


FIG. 2

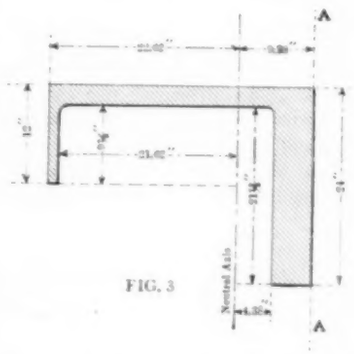


FIG. 3

PUNCHING- AND SHEARING-MACHINE FRAME SECTIONS

and safer to calculate it, using the formula $I = \frac{B H^3}{3}$ for a rectangular figure about its base, where B is the breadth and H the hight of the rectangle in inches.

Let us take the section in Fig. 2 with its equivalent section in Fig. 3. The neutral axis passes through the center of gravity, and this must first be found. Divide the figure into convenient rectangles. Multiply the area of each rectangle by the distance of its center of gravity from any line, say AA. Add together the moments thus obtained and divide the total by the area of the whole section. This gives the distance of the center of gravity of the section from the base line. It is advisable to tabulate as follows:

Areas in Square Inches.	Distance of Centers of Gravity from $A\,A$.	Moments About $A\,A$.
$24 \times 5 = 120$	$2\frac{1}{2}$ inches.	300
$26 \times 2\frac{1}{2} = 65$	18 inches.	1170
$12 \times 1 = 12$	$31\frac{1}{2}$ inches.	378

Total area = 197 square inches.
Total moment = 1848.
Distance of center of gravity of section fr m $A\,A$

$$= \frac{\text{total moment}}{\text{area}} = \frac{1848}{197} = 9.38 \text{ inches.}$$

Take the moments of inertia of the inclosing rectangles on either side of the neutral axis and subtract from them the moments of inertia of the spaces, so that for this section:

$$I = \tfrac{1}{3}\,(24 \times 9.38^3 - 21\tfrac{1}{2} \times 4.38^3 + 12 \times 22.62^3 - 9\tfrac{1}{2} \times 21.62^3) = 20{,}300.$$

The pressure for punching was 70.8 tons.

Its leverage $L = 27$ inches $+ 9.38$ inches $= 36.38$ inches.

The bending moment $M = P \times L = 70.8 \times 36.38 = 2575$ inch tons.

The maximum tensile stress $=$

$$\frac{Mh_1}{I} + \frac{P}{A} = \frac{2575 \times 9.38}{20{,}300} \quad \frac{70.8}{197}$$

$= 1.19 + 0.36 = 1.55$ tons per square inch.

This should not exceed 1¾ tons per square inch.

The maximum compressive stress $=$

$$\frac{Mh_2}{I} = \frac{P}{A} = \frac{2575 \times 22.62}{20{,}300} \quad \frac{70.8}{198}$$

$= 2.87 - 0.36 = 2.51$ tons per square inch.

This may be three times the tensile stress.

Sometimes doubt exists as to the actual load on a frame. In the case of gate shears, practically the whole load at the commencement of the cut comes on one standard, and toward the end of the cut on the other. With a multiple punching machine the pressure is distributed along the slide half of it coming on each standard.

For such calculations as these the slide rule can be used to great advantage. The degree of accuracy obtained by its use is quite sufficient when we take into account the errors to which we are liable because of our present lack of information regarding the penetration for various thicknesses of plate.

M——, England.

A simple plan of recovering tin and solder from old tin cans and other scrap is to run them in a perforated tumbling barrel which is mounted over a small fire of any kind. A hood or casing of sheet iron surrounds the whole thing to keep in the heat. The rotation gives the whole contents an equal heating, and the melted solder and tin flow down into a trough made for them. The plan and apparatus have been patented by John H. Bills, of Laramie, Wyoming.

A Standard for Short Involute Gear Teeth

By Charles H. Logue

There is a growing demand for an improved standard of gear-teeth proportions, as it is becoming more and more evident under the stress of modern requirements that the present system is not all that it should be. Anyone who has ever attempted to lay out templets of an angle of obliquity of 14½ degrees, or even attempted to design a gear tooth to engage with the existing standard, can appreciate this. If the gears are successful it is more good luck or second sight than good management.

This demand has been more noticeable since the advent of the automobile, which requires gears of the highest efficiency in order to economize weight and space. To meet this need, a style of tooth has been evolved known as the STUBBED 20-DEGREE INVOLUTE, which gives excellent results.

Its system is arranged as follows:

The angle of obliquity is made 20 degrees instead of 14½ degrees. The addendum is made to correspond with the addendum of a pitch one or more sizes finer than the actual pitch, as:

Actual pitch	2	2½	3	4	5	6	7	8	9	10	12	14	16	18	20	24
Pitch depth	2½	3	4	5	6	7	8	9	10	11	12	14	18	20	24	28	38

The upper figure indicates the pitch of the gear in question, and the lower figure indicates the pitch from which the addendum is taken. For example, a gear of 8 diametral pitch would ordinarily have an addendum of ⅛ inch, but according to the above proportions the addendum would be made to correspond with 10 diametral pitch, which would make it 1/10-inch instead. This would be written 8/10 pitch.

It will be found, however, that this system does not give a uniform depth of tooth, the addendum sometimes being a little more and sometimes a little less than 0.25 of the circular pitch, as follows:

For $\frac{2}{2\frac{1}{2}}$ pitch, addendum = 0.255 of circular pitch

For $\frac{2\frac{1}{2}}{3}$ pitch, addendum = 0.264 of circular pitch

For $\frac{3}{4}$ pitch, addendum = 0.240 of circular pitch

For $\frac{4}{5}$ pitch, addendum = 0.255 of circular pitch

For $\frac{5}{7}$ pitch, addendum = 0.228 of circular pitch

For $\frac{7}{9}$ pitch, addendum = 0.247 of circular pitch

For $\frac{8}{10}$ pitch, addendum = 0.254 of circular pitch

For $\frac{10}{12}$ pitch, addendum = 0.264 of circular pitch

For $\frac{12}{14}$ pitch, addendum = 0.226 of circular pitch

For $\frac{14}{18}$ pitch, addendum = 0.250 of circular pitch

It is evident that some confusion is liable to arise in the selection of the numerator or pitch depth. This is especially true in respect to circular pitch. Any plan for universal adoption should have a base from which all pitches can be proportioned. Such is not the case with this system.

In view of these facts I submit the following proportions for consideration:

Angle of obliquity	20 deg. instead of 14½ deg.
Addendum	0.25 × circ. pitch instead of 0.3183
Dedendum	0.30 × circ. pitch instead of 0.3683
Working depth	0.50 × circ. pitch instead of 0.6366
Whole "	0.55 × circ. pitch instead of 0.6866
Clearance	0.05 × circ. pitch, as now used.

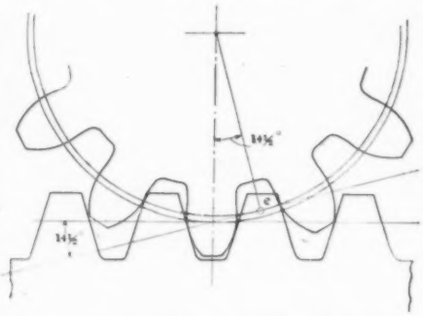


FIG. 1. INTERFERENCE OF RACK AND PINION

For Diametral Pitch.

Addendum	$= \frac{0.7854}{P}$	instead of	$\frac{1}{P}$
Dedendum	$= \frac{0.9424}{P}$	instead of	$\frac{1.57}{P}$
Working depth	$= \frac{1.5708}{P}$	instead of	$\frac{2}{P}$
Whole depth	$= \frac{1.7278}{P}$	instead of	$\frac{2.157}{P}$
Clearance	$= \frac{0.157}{P}$	, as now used.	

The above system has some desirable features. The principal constants are well known in general engineering formulas and are easily memorized; the addendum, for instance, is one-quarter of the circular pitch, or one-half the thickness of the tooth at the pitch line. It is therefore only necessary to add the thickness of the tooth to the pitch diameter to determine the outside diameter. The constant for the addendum for diametral pitch is one-fourth of 3.1416, or 0.7854.

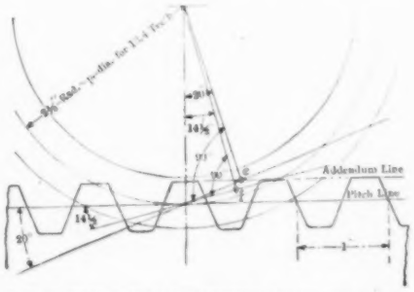


FIG. 2. GRAPHICAL DEMONSTRATION OF ANGLE OF OBLIQUITY FOR A 13.4 TOOTHED PINION ENGAGING WITH A RACK

It is believed that our present system owes its existence to the fact that the outside diameter may be determined by adding two to the number of teeth and figuring as for the pitch diameter. It must be admitted that this is very convenient, but it should not stand in the way of the adoption of a more efficient standard.

The principal objection to the system of 14½ degrees involute is the fact that a gear of less than thirty teeth cannot be used without interference. The points of the mating tooth cut into the flank of the pinion tooth, unless a considerable portion of the flank is cut away. On a twelve-tooth pinion, for instance, there is no contact below the base circle; and as the pitch circle and the base circle are very close together for this number of teeth, nearly one-half of the tooth is of no service whatever. This interference is most noticeable when a rack is engaged, as illustrated in Fig. 1.

To use a twelve-tooth pinion in an interchangeable system of 14½ degrees the system must be corrected. This is generally accomplished by rounding the points of the rack teeth and cutting away the flanks of the pinion teeth below the base line. The points of the gear teeth should also be rounded somewhat, although this is not always done. Some prefer to round the points of the teeth in order to give more strength to the flanks, while again some make the entire correction in the flanks, maintaining the true involute curve as far as possible. I believe this latter plan is the better as any modifications of the involute curve will lead to variations in the action of the teeth, causing rapid wear and crystallization of the material. There seems to be no recognized way of making the corrections referred to. As a result, gears formed by cutters made by one manufacturer will not properly engage gears cut with another make of cutters.

Formulas for determining the smallest angle, or the least number of teeth of a pinion that will engage a standard rack of a given angle without interference, are as follows:

B = Angle of obliquity,
N = Least number of teeth.
A = Addendum for 1-inch pitch.

$$Sine\ B^2 = \frac{6.282 \times A}{N}.$$

Assume $N = 13$, and $A = 0.25$, then,

$$Sine\ B^2 = \frac{6.282 \times 0.25}{13} = \sqrt{0.1208} = 0.348.$$

Angle whose *Sine* is 0.348 = 20 degrees 20 minutes, angle of obliquity.

Assuming the angle of obliquity to be 20 degrees, the least number of teeth to be used without interference is found as follows:

$$N = \frac{6.282 \times A}{Sine\ B^2}.$$

Then, if $B = 20$ degrees
$Sine\ B^2 = 0.342^2$, $= 0.117$
$A = 0.25$

$$\text{Then, } N = \frac{6.282 \times 0.25}{0.117} = 13.4 \text{ teeth.}$$

This indicates that thirteen teeth can be used in the system proposed, with very little or no correction.

A graphical illustration of the above formula is shown in Fig. 2.

In the illustration no interference will occur so long as point *e* falls outside of the addendum line of the rack. It will be noticed that for 20 degrees this point falls just on this line, showing that 13.4 teeth are the least possible number to be used with that angle. It is evident that this method may be used to determine either the lowest permissible number of teeth, or the proper angle to allow for the use of a certain number. Point *f* locates the beginning of the interference had the angle been 14½ degrees instead of 20 degrees.

From this it is seen that, with the system proposed no interference will be found in the use of a thirteen-tooth pinion; therefore, no correction will be needed except for twelve teeth. This will

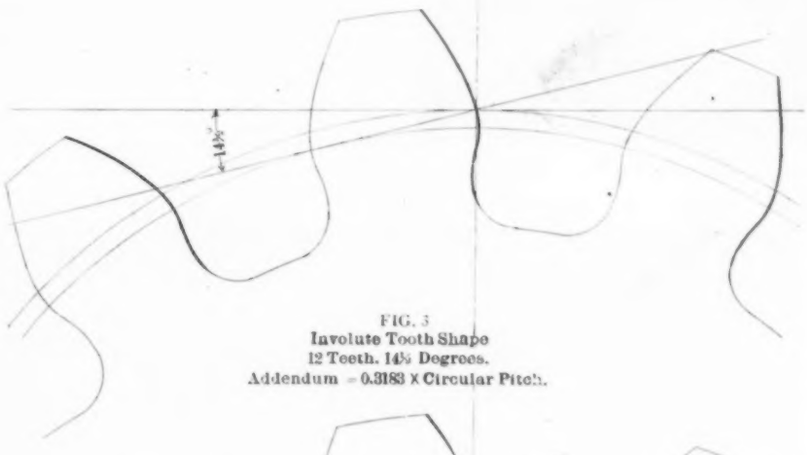


FIG. 3
Involute Tooth Shape
12 Teeth. 14½ Degrees.
Addendum = 0.3183 × Circular Pitch.

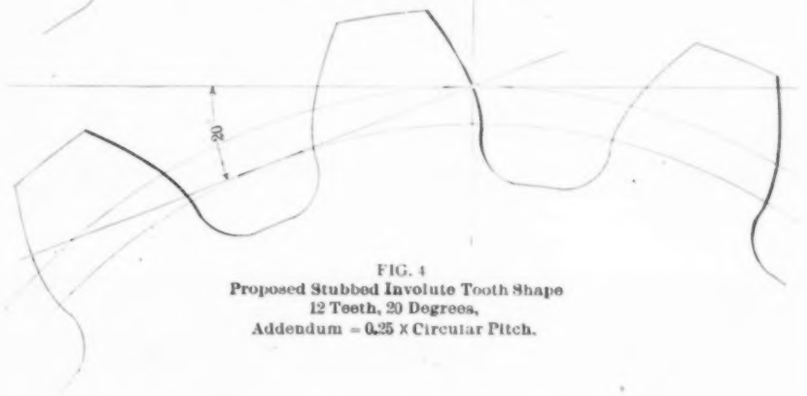


FIG. 4
Proposed Stubbed Involute Tooth Shape
12 Teeth, 20 Degrees,
Addendum = 0.25 × Circular Pitch.

be slight. Undercutting is done away with, and the system is theoretically correct, so that anyone understanding the principle of the involute curve can lay out the teeth correctly. It has been generally thought that to increase the angle from 14½ degrees to 20 degrees would greatly increase the pressure on the journals. It has been demonstrated, however, that such is not the case. Quoting from Wilfred Lewis, in the AMERICAN MACHINIST, Volume 24, Part 1, page 218:

"The pressure on journals for different degrees of obliquity is measured by the secant of the angle, and not by the tangent, and the three systems should, therefore, be compared as follows:

"11 deg. cycloidal, secant 11 deg. = 1.0187
14½ deg. involute, secant 14½ deg. = 1.0329
15 deg. involute, secant 15 deg. = 1.0353"

Similarly for 20 degrees:

20 deg. involute, secant 20 deg. = 1.0641

Quoting again: "The differences in journal pressure for these systems are therefore very slight, and their differences in efficiency are still less, because, as demonstrated by George B. Grant some years ago, the obliquity of action in involute gearing has no effect whatever upon the friction loss in the teeth themselves. The sliding diminishes at the same rate as the pressure increases, and the loss in effect, whatever it may be, is wholly due to journal friction.

"The wear on the teeth of pinions will be less concentrated at this base line, and by avoiding interference, their arc of action is actually increased. It may be urged that the whole load is necessarily concentrated on a single tooth, and without denying this, I maintain that such is generally the case in any system of gearing, however long the arc of action may appear on paper. A division of the load on several teeth implies absolute perfection in forming and spacing the teeth, a condition never attained in practice, and it is therefore never safe to assume that the load is carried by more than one tooth under any circumstances."

By increasing the angle we lengthen the arc of contact; by shortening the tooth extreme sliding contact is avoided, and the load is concentrated on parts where it can be best borne. It is reasonable to assume therefore that there will be even less pressure on the journals than with the present system, as the pressure on the teeth would tend to hold the axles normal in one case and push them apart in the other, in proportion to the tangent of the angle.

Since the introduction of cut gears for heavy work as in rolling mills and cement plants, the tendency has been toward an increased angle and a shorter addendum. The cause of this is the fact that the imperfections in the standard tooth are increased proportionally and unfit the gears for the heavy duty for which they are intended. It can be readily seen that any doctoring of the involute curve will cause an uneven motion in the rotation of the gears which will absorb power and destroy the teeth.

A pair of gears in which the lowest number of teeth approaches thirty of 14½ degrees will require very little correction, and for thirty teeth or more in the pinion no correction at all will be needed. It will also be found that a lower number of teeth may be used without interference by simply reducing the addendum, leaving the angle as it is. The addendum should not be made less than twenty parts of the pitch, although this depends much on the number of teeth in the gears engaged. Aside from the increased efficiency of the system proposed, there is an increase of 40 per cent. in the strength of the teeth in extreme cases. This is owing to the increase in thickness of the tooth at the root and to shortening the leverage on the tooth. The cuts Figs. 3 and 4 are self explanatory. It is apparent that there is a saving in material in the proposed shape of tooth.

With bevel gears the depth of tooth can be made any dimension desired without extra cost, as the operation and construction of bevel planing machines allow for this. Also with modern generating machines the angle of obliquity may be made as desired, without extra tools or operations.

A set of eight cutters for each pitch will not produce sufficiently accurate gears for these requirements. It is evident that a cutter made just right for thirty-five teeth (No. 3) will make considerable error in the tooth curve when used for fifty-five teeth. To remedy this defect cutters should be made in sixteen numbers, as follows:

No.	Cuts						
8	12	teeth,	made	for	12	teeth
7½	13	teeth,	made	for	13	teeth
7	14	teeth,	made	for	14	teeth
6½	15 and 16	teeth,	made	for	15	teeth
6	17 and 18	teeth,	made	for	17	teeth
5½	19 and 20	teeth,	made	for	19	teeth
5	21 and 22	teeth,	made	for	21	teeth
4½	23 to 25	teeth,	made	for	23	teeth
4	26 to 29	teeth,	made	for	26	teeth
3½	30 to 34	teeth,	made	for	30	teeth
3	35 to 44	teeth,	made	for	35	teeth
2½	45 to 54	teeth,	made	for	45	teeth
2	55 to 79	teeth,	made	for	55	teeth
1½	80 to 134	teeth,	made	for	80	teeth
1	135 and up,		made	for	135	teeth
0	Rack teeth only.						

With the regular system of 14½ obliquity one cutter less than the above

could probably be used, as the No. 1 cutter is used to cut from 135 teeth to the rack. In the proposed system the rack teeth would have straight sides, and the No. 1 cutter would not serve.

Etching Malleable Iron for the Visual Investigation of Structure *

By Prof. E. Heyn

In describing some of the lessons which may be learned as to the structure of iron and steel by inspecting etched surfaces, attention will be directed principally to the results obtained by an examination with the unaided eye.

It is advisable to employ such etching reagents as allow of a subsequent microscopic examination, for only in that way can the investigator avoid the danger of drawing erroneous conclusions. Hence the necessity for preparing photomicrographs cannot be altogether obviated if the results of a visual examination are to be trustworthy.

The author is unable to recommend the use of hydrochloric acid, which is so often adopted as the etching fluid. As will be shown later, it eats certain constituents of the metal away and so makes holes. Moreover, owing to hollow places in the original sample, or to depressions produced during the action of the acid, it undercuts the material and comes into contact with a large extent of surface, until deep cavities are made to appear where there were none, or where only trivial flaws existed at first. Again, samples etched with hydrochloric acid cannot be subsequently examined under the microscope. To avoid all these inconveniences, cuprammonium chloride has been adopted at the testing laboratory as the etching reagent, a solution being prepared by dissolving 1 gram of the solid in 12 grams of water.

When special circumstances do not call for an alteration in the rule, transverse sections of the metal are prepared with a thickness of about 10 millimeters. They are ground with emery cloths of different degrees of fineness, and are finally polished on cloth-covered buffs with rouge and water. The preparation usually occupies about two hours. With its prepared surface upward, the sample is then quickly dropped into the etching fluid in a large glass or papier-maché dish. The introduction of the sample into the liquid requires a certain amount of practice if lines and markings are to be avoided, the operation being performed in a manner resembling the immersion of a photographic plate in its developer. A formation of bubbles must also be prevented, or parts of the metal will be protected from the fluid, and small spots will be left in relief which reflect light. The etching takes about one minute. Owing to the reaction between the iron of the metal and the copper in the solution, spongy copper separates upon the ground surface, and is removed by rubbing it with a pad of cotton wool after the sample has been transferred to a vessel of water, through which a constant stream of fresh water is preferably kept flowing. If the concentration of the etching liquid is as specified (1 : 12) the copper is very easy to remove; but if it is too weak, the copper adheres firmly, rendering the etching operation unsuccessful. Too highly concentrated solutions act too quickly and powerfully and exhibit no advantage. When the washing is complete, the sample is rinsed in a little alcohol, and carefully dried by dabbing it with a soft handkerchief—it should not be rubbed lest the surface be injured. So prepared, the specimens keep fairly well without rusting in ordinary air, and may be preserved indefinitely in an atmosphere dried with calcium chloride.

Cuprammonium chloride is not suitable for the etching of cast iron containing graphite, for the galvanic action of the latter causes the deposited copper to adhere firmly to the surface. It can, however, be used with perfect success in the treatment of white cast iron and ordinary carbon steels, especially when they are not hardened. The copper adheres firmly to the surfaces of special steels, such as contain much nickel or chromium; and therefore the nature of these steels becomes manifest during the etching operation. Special steels must accordingly be etched with other fluids.

The different structural components of iron-carbon alloys are attacked in a very similar fashion by cuprammonium chloride. Holes are not eaten away, nor appreciably increased in size by the etching. If, therefore, cavities or microscopic depressions are noticed on the etched surface, they must have been there originally, and are not the result of the etching process. This is a notable advantage possessed by cuprammonium chloride over hydrochloric acid. Minute pores or cavities in iron are easily closed up by polishing, thus becoming invisible before the surface is etched. Some time after the metal has been etched with cuprammonium chloride, however, the cavities are rendered very distinct, for liquid (especially the alcohol used for rinsing the surface) exudes from them. Such exudation may occur repeatedly, and if the liquid is not wiped away, marks may be produced in the vicinity of the pores which an unpractised investigator may confuse with the dark colorations due to other causes.

Etching by means of cuprammonium chloride is very useful in detecting spots of high carbon or phosphorus content; also in bringing into notice permanent deformations the metal may have suffered in the cold.

FIG. 1. STEEL SUPERFICIALLY DECARBONIZED

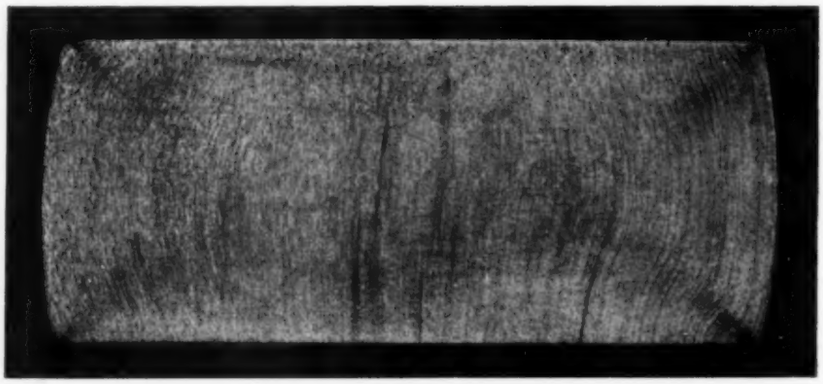


FIG. 2. A CYLINDER AFTER FLATTENING

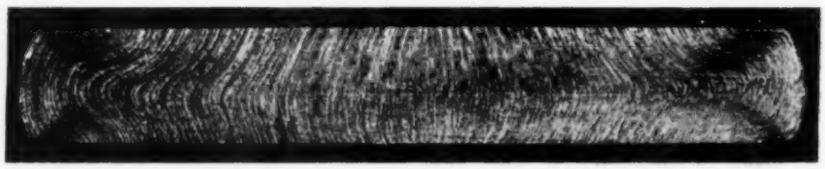


FIG. 3. ANOTHER CYLINDER AFTER FLATTENING

*Abstract of a report presented to the International Association for Testing Materials, Brussels Congress.

Distribution of the Carbon

Spots of high carbon content in unhardened malleable iron appear dark after etching. This is due to the fact that pearlite is darkened by cuprammonium chloride, whereas ferrite remains uncolored. Parts of the metal richer than others in carbon look darker, therefore, because they contain more pearlite. The effect may be seen in Fig. 1 which is the representation of a piece of steel superficially decarburized by prolonged heating. The margin consists of an iron with an amount of carbon that is practically nil. The margin incloses a darker core containing the original high percentage of carbon. As a surface etched with cuprammonium chloride is suitable for examination under the microscope, it may advisedly be submitted to such investigation in order to obtain confirmatory evidence of the irregular distribution of the carbon. From the ratio of pearlite and ferrite, it is even possible to judge of the amount of carbon present in different parts of the prepared surface: that is to say, to carry out carbon estimations under the microscope. This is specially important when the effect of tempering or case-hardening has to be ascertained. In the latter instance the depth of the carburized layer and the approximate amount of carbon in it can be judged. The sample should be etched before being chilled in water, for the chilling renders an estimation of the carbon content impossible. When it is desired to examine the carburized portion of a sample that has already been chilled, it must first be heated, preferably in a bath of molten metal, so that loss of carbon by oxidation may be prevented.

FIG. 4. SECTION OF AN INGOT

Appearance of Spots Rich in Phosphorus

A fragment of phosphoritic metal containing 0.08 per cent. of carbon, 0.27 per cent. of manganese, and 0.28 per cent. of phosphorus, was artificially inserted in the center of a piece of steel containing only 0.01 per cent. of phosphorus, 0.07 per cent. of carbon, and 0.10 per cent. of manganese: the whole being ground and etched for one minute with cuprammonium chloride. The phosphoritic center assumed a dark color with the suggestion of a bronze-like tint, whereas the purer margins remained pale. After a little practice it is possible to distinguish between the dark coloration of the core due to high phosphorus content and the dark color produced by much carbon; but in cases of doubt the microscope can be referred to.

The darkening action of cuprammonium chloride upon spots rich in phosphorus depends on the fact that crystals of ferrite containing iron phosphide in solid solution are colored more deeply than spots which contain less or no phosphorus.

Recognition of Cold-worked Spots

When cuprammonium chloride is used to etch a piece of iron that has undergone more severe permanent deformation in one place than in another, the spots which have suffered most appear the darker—more particularly if the stresses were of a tensional or shearing character. This may be seen in Figs. 2 and 3, which represent longitudinal sections through two cylinders of steel originally 20 millimeters in diameter and 20 millimeters in hight, after being upset. The sample in Fig. 2 has been decreased in hight by 8.7 millimeters, and that in Fig. 3 by 14 millimeters through the treatment. The effect is most noticeable in the diagonals, which therefore appear dark after etching. The cause of the deeper coloring may be recognized under the microscope. In the direction of the stress furrows of some microscopic depth and size have been eaten away during the etching operation, and their number locally diminishes the power of the prepared surface to reflect light. Hence the spots seem darker to the unassisted eye. A further indication of the deformation will be found in the shape of the iron granules, which are no longer equiaxial but elongated.

Investigation of an Ingot

Fig. 4 is of interest as showing cavities in one quarter of an ingot. The deep black markings show these cavities. This was investigated in connection with some girders rolled from the ingot to find the effect of the cavities upon the girder structure. In spite of the blow-holes in the ingot the girders were free from pores or holes; the blow-holes were welded together.

Tempering an Iron Cutter

There has always been more or less of a mystery hanging over the appearance of colors in the tempering of steel and everyone who has ever tried his hand at hardening knows the elusiveness of the exact color scheme that will always produce the degree of hardness you desire. It is about as dependable as the weather during the present spring.

A case comes to mind of one of these "know-it-all" chaps—he wasn't a tech. man, either—who could always tell the different kinds of steel and almost anything else you could name.

So one day a cub, who had heard him blow his own horn, filed up a flat piece of iron the same shape as a cutter the expert was about to harden, and quietly slipped it in place of the other and watched the result.

It was heated, quenched and then polished a little to see the colors run as usual. And they ran just as he expected, so the piece was cooled and put in the milling machine.

Of course it didn't cut. 'Twas as soft as good wrought iron can be, but it had a color scale that would have done credit to a very pretentious book on hardening.

A Driving Mechanism for Percussion Machines*

A French Invention in Which a Crank-driven Hammer Is Free at the Instant of Striking; Force of the Blow Readily Regulated

BY M. ED. SAUVAGE

A contrivance which permits in such machines as power hammers, stamping and embossing machines, etc., of the hammer or ram being driven downward until the pin of the driving crank has attained its maximum velocity, after which point the ram goes on the remainder of the way down till it strikes the work with this maximum velocity, has been devised by M. Luc Denis. After the hammer has struck the work it is again picked up by the crank-pin when the latter passes its lowest position. Furthermore, the intensity of the impact may be varied by a simple feature which regulates the velocity which the ram has, at the moment of its separation from the crank-pin, received from the latter.

The Nub of the Invention

The action of the device in its elementary form will be evident from Figs. 1, 2 and 3, of which the first is an elevation of the slotted crosshead with the crank-pin; Fig. 2, a partial elevation and vertical section of such a machine; and Fig. 3 a view similar to Fig. 1, showing how the point of separation is varied. It will be seen that the crosshead is practically a modified "Scotch yoke," with a horizontal slot in which the roll or bushing on the crank-pin plays. The crank is assumed to have a uniform angular velocity. Starting with the pin at the bottom, contact is made with the upper edge of the slot, and during one-half revolution the crosshead and ram are lifted. During the third quarter-revolution, contact is made with the lower edge of the slot, the motion of the ram being harmonic, its downward velocity continually undergoing an acceleration. At the end of this quadrant, the notch in the upper edge of the slot being over the roll and the vertical component of the velocity of the pin beginning to decrease, the crosshead keeps on going with the maximum velocity given it by the crank, the roll gradually passing up into the notch in the upper surface of the slot. Of course, theoretically the ram is meanwhile gaining some additional velocity due to the accelerating action of gravity, but in view of the short hight of the free fall and the velocity of the ram at its commencement, this acceleration is negligible. The form of the notch in the upper face of the groove is that of a cycloid parallel to the cycloid which the center of the crank-pin describes with reference to the cross-head, the distance between the two cycloids being equal to the radius of the roll, or in some cases it may be made a little greater to allow for recoil. This arrangement permits of blows being struck very rapidly in spite of the fact that the ram is free and disengaged when it strikes the work.

To accommodate the hammer to varying thicknesses of work, without the necessity of having to make any adjustments, the crosshead is clamped on the ram, the amount of friction being regulated so as to permit slipping when the resistance of the work somewhat exceeds the force developed by inertia.

The intensity of the blow may be varied

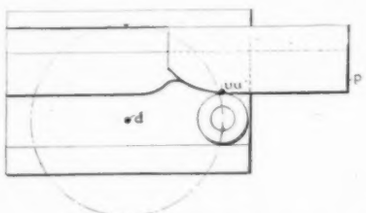


FIG. 1. CROSS-HEAD WITH CRANK-PIN AND ROLL IN THE GROOVE

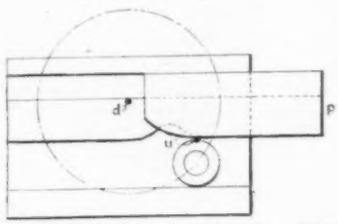


FIG. 3. CROSS-HEAD, SHOWING MOVABLE PIECE FOR REGULATING FORCE OF BLOW

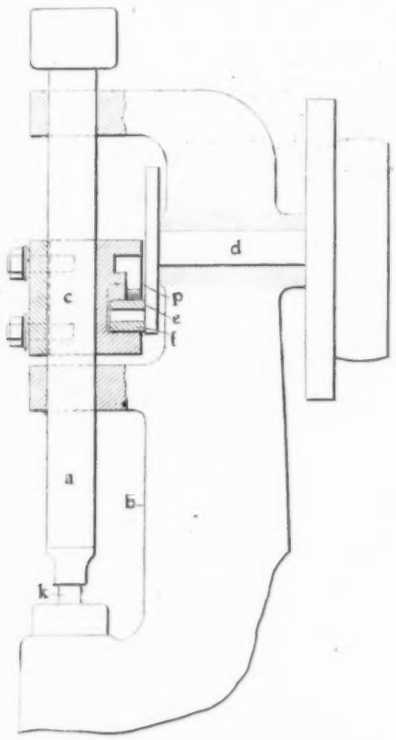


FIG. 2. SIMPLE FORM OF LUC DENIS HAMMER

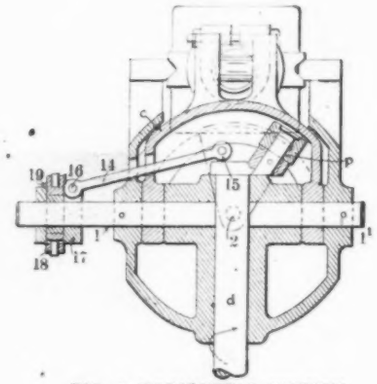


FIG. 4. HORIZONTAL SECTION

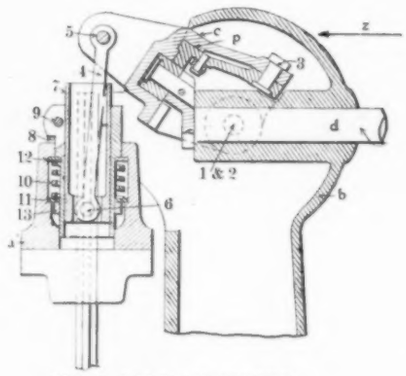


FIG. 5. VERTICAL SECTION

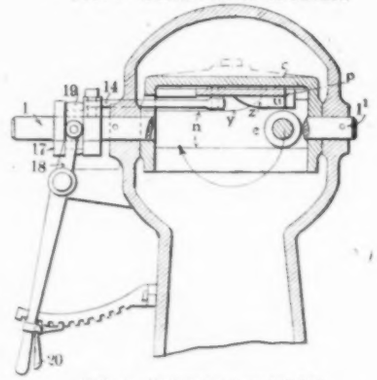


FIG. 6. VERTICAL SECTION
Looking in direction of arrow *z*, Fig. 5, but crank in different position.

POWER HAMMER, WITH FORCE OF BLOW REGULATABLE WHILE RUNNING

*Translated and adapted from the *Bulletin* of the Société d'Encouragement pour l'Industrie Nationale.

without changing the speed of rotation of the shaft. This is done by compelling the ram to remain in engagement with the crank-pin until a later period in the downward movement of the latter, the vertical component of its velocity being therefore, of course, less. This is accomplished by pushing in the piece *p* to the left, as shown in Fig. 3, modifying the form of the notch and delaying the entry of the roll into it.

To provide against shock to the parts from recoil, it is in some cases found desirable to allow some play in the slot above the roll, and sometimes a spring mechanism may be introduced; in general the action is so rapid that the ram is caught up and lifted again by the crank before there is time for any injurious recoil shock.

An Arrangement of the Apparatus Permitting Regulation While Running

Several applications of the device are shown. In the arrangement shown in Figs. 4, 5 and 6, the regulation of the force of the blow may be made without its being necessary to stop the machine. In this design, instead of employing the ordinary crank with the axis of the pin parallel to the axis of the shaft, what is called a "conical crank" is used. Fig. 5 is a vertical section; Fig. 6 is also a vertical section on a plane at right angles to that of Fig. 5, the direction in which the parts are viewed being that of the arrow *z* Fig. 5; Fig. 4 is a horizontal section. *d* is the driving shaft, carrying on its extremity a crank with the axis of the pin forming an oblique angle with the shaft. Upon this pin runs the bushing or roll. The groove in which this roll works is formed in a casting *c*, which oscillates in a vertical plane about the horizontal axis of the divided shaft 1′, which axis intersects that of *d* in the point 2, through which point also passes the axis of the crank-pin; this point 2 therefore is the center of a sphere upon which the path of the crank-pin is traced.

The casting or rocker *c* has on its outer end lugs to which are pinned the connecting-rod or link 4, the other end of which is pinned in the plunger 7. Around the plunger 7 is clamped by means of the bolt 9 a sleeve 8, which drives the ram. The variation in the hight of the work is taken care of as before by the friction slipping device; the coil spring 10 is in-

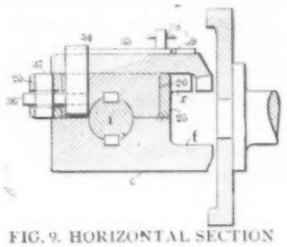


FIG. 9. HORIZONTAL SECTION

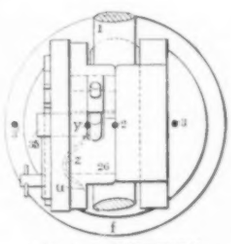


FIG. 10. ELEVATION

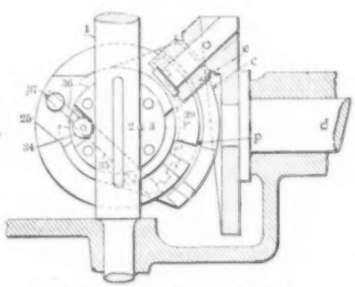


FIG. 11. VERTICAL SECTION

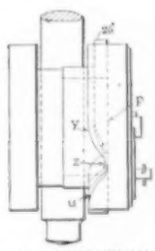


FIG. 12. ELEVATION

DETAIL OF "CONICAL-CRANK" MECHANISM

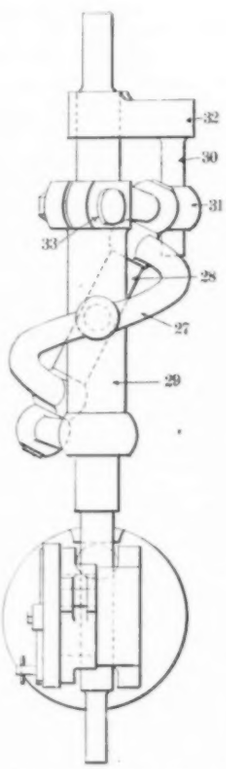


FIG. 7. ELEVATION OF THE LEVER AND PARTS WHICH DRIVE IT.

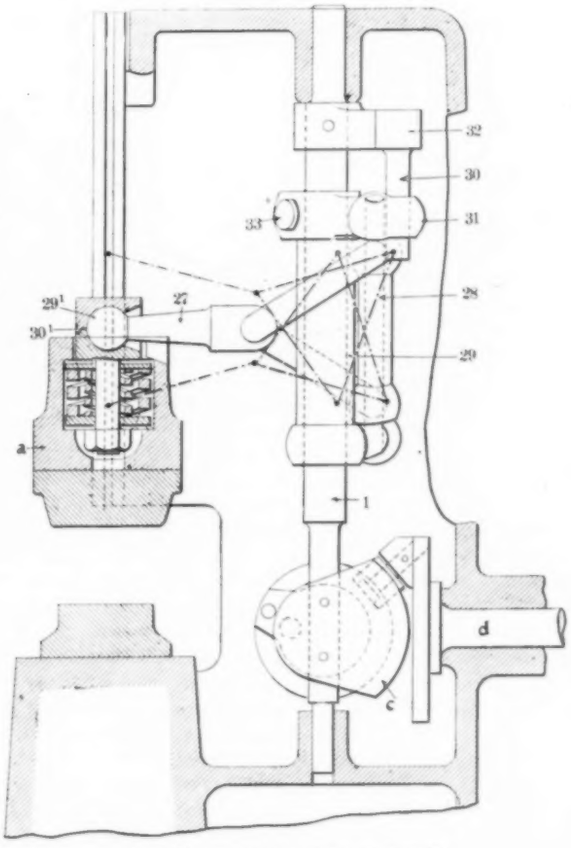


FIG. 8. ELEVATION PARTLY IN SECTION.

POWER HAMMER WITH CONICAL CRANK, LEVER AND STRAIGHT-LINE MOTION

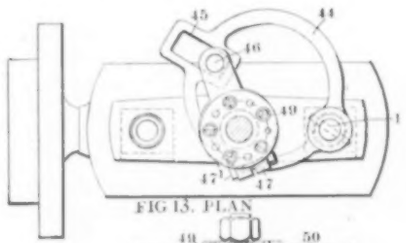


FIG. 13. PLAN

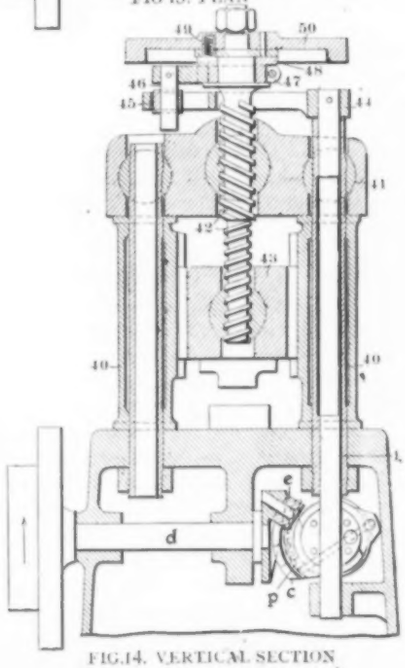


FIG. 14. VERTICAL SECTION

FLY-PRESS WITH LUC DENIS DRIVE

terposed between the ram and the sleeve collar so as to avoid shocks on the driving mechanism.

The arrangement of the parts for varying the instant of release of the ram from the crank-pin is best seen in Fig. 6. The controlling piece *p* in this case is pivoted at 3, as shown in Fig. 5, and its position is regulated by the hand lever 20, Fig. 6, by means of the ring 19, the grooved collar 17, and the link 14; it is very apparent that this regulation can be performed without stopping the machine.

Another Form, with a Peculiar Straight-line Motion

In Figs. 7 to 12 is shown another form of this apparatus in which, incidentally, is embodied an odd straight-line motion. Figs. 7 and 8 are elevations, at right angles to each other, the latter being in part section; Fig. 11 is a vertical section to a larger scale of the conical crank and neighboring parts; Fig. 10 an elevation of the same; Fig. 9 a horizontal section, and Fig. 12 an elevation of the opposite side from Fig. 10. *d* is, as before, the main driving shaft, having on its end the conical crank, which in this case serves to cause the vertical shaft 1 to oscillate. The motion of the rocker *c* here resembles that of the corresponding piece in the machine previously described, with the exception that here the axis of oscillation is vertical instead of horizontal, and the conical crank is on the outside of the sphere instead of inside of it; in this case there is no provision made for adjusting the force of the blow while the machine is in motion, this adjustment being made by varying the position of a small lever 35 on the piece *c*. This lever 35 is mounted on the end of a short shaft 34, see Figs. 9 and 11, which carries an arm 36 with a pin 37 working in the collar 25, Figs. 9 and 12. The piece *p* forms part of this collar. It is evident that if the lever 35 be raised out of the notches in the sector (it will spring enough to permit of this) and shifted in position, the collar 25 and therefore the piece *p* will likewise be altered in position; this manipulation, of course, cannot be performed with the machine running.

The Straight-line Motion

The straight-line motion is carried by a double-headed sleeve 29 clamped on the vertical rockshaft 1, the amount of the friction being regulated by the clamping bolt 33, so as to permit of slipping to accommodate varying thicknesses of the work, as before. The sleeve is caused to oscillate with the shaft by means of the arm 32 and pin 30, working in a socket 31 so as to permit of the vertical motion of the sleeve. In the upper and lower heads of the sleeve is journaled the inclined rock-shaft 28, having fixed to it a lever 27. Since the lever leads off on the other side of the shaft 1 from the rock-shaft 28, it is formed with curved forked ends encircling the vertical shaft so as to reach the inclined shaft. The angle at which the shaft 28 is placed, its distance from the shaft 1, and the distance of the ball end 29′ of lever 27 from the shaft 28, are all so proportioned that when the rock-shaft 1 is given the maximum amount of oscillation, the ball 29′ will describe a curve of which the portion within the limits of its vertical stroke is so flat as to be practically a straight line, so that it may follow the vertical course of the ram, which it drives through the medium of the helical springs shown.

Application to a Fly-press

Fig. 13 is a horizontal, and Fig. 14 a vertical section of a fly-press to which this

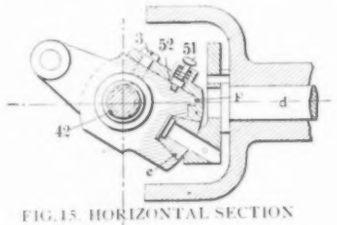


FIG. 15. HORIZONTAL SECTION

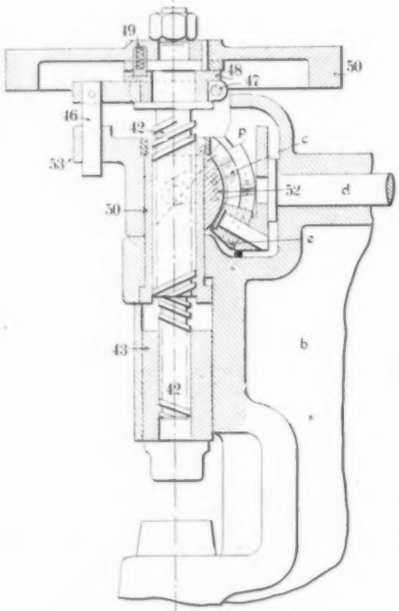


FIG. 16. VERTICAL SECTION

FLY-PRESS OF "GOOSE-NECK" TYPE

mechanism has been applied. The main driving shaft *d*, the vertical rock-shaft 1, and the intermediate parts are similar to those just described. The cross-beam 41 is carried by two hollow columns 40, through one of which passes the vertical rock-shaft. The screw 42 has right- and left-hand threads, the former working in a nut in the ram 43, the latter working in a nut in the cross-beam 41. Upon the top of the screw is carried the fly-wheel 50. To the vertical rock-shaft 1 at its upper end is fixed a lever 44, with a slot 45 at its outer end. Through a block working in this slot passes a pin 46 fixed in an arm on the collar 47, the latter being clamped on the ring 48 by means of the bolt 47′. The fly-wheel and vertical screw are driven by means of a circle of spring plungers 49.

A More Compact Design of Fly-press

The machine shown in Figs. 16 and 15 in vertical and horizontal sections respectively is a fly-press of what is called a "goose-neck" type, and though in its mechanical elements similar to the one just described, the design is much more compact, the vertical axis of oscillation of the rocker *c* being made to coincide with the axis of the screw and fly-wheel, and the rock-shaft 1 being thereby eliminated. In the horizontal section is very plainly shown the pivot 3, about which the adjusting piece *p* turns, also the spring latch 51 for holding the latter in any desired position. The lever 44 of Fig. 13 is here replaced by the arm 53 formed on the rocker *c*. The remainder of the mechanism is just like that of Figs. 13 and 14, the momentum stored up in the fly-wheel being utilized at the instant of impact in the same manner.

A multiple stamping machine on this principle has been applied to the automatic fabrication of shoe buttons, stamping them in the form of hemispheres out of sheets.

Machine Tools in Turkey

The machine tools mostly in demand here are lathes, planers, and drills, with their full line of accessories. Milling machines, so common in American machine shops, are not used here, probably owing to the lack of specialized work. The lathes are, almost without exception, of the gap type—that is, the bed is broken near the headstock to allow the turning of work exceeding in diameter the normal swing of the lathe. Planers and shapers are of the usual style, with only the slight difference existing between the English and American practice. Drills are also similar to the American types, but of heavier build. Blacksmith drills are of the bench type for hand power, and they differ from the American tool in having the fly-wheel mounted on the top and horizontally instead of on the side and vertically.

A Leeds correspondent of the London *Times* states that a noticeable order from the Afghanistan government has in part been executed by a firm of that British manufacturing city in the despatch of leather-dressing machinery of the value of about $15,000. It is stated that the Ameer has in view a considerable development of his leather works at Kabul. This machinery has been packed in about 400 cases for the convenience of carriage through the Khyber pass. It is stated that another firm of Leeds and Leicester has in hand from the same quarter an order for a plant of boot-making machinery.

Induction-motor Planer Drive with and without Fly-wheel *

By Howard P. Fairfield

The ordinary type of metal planing machine has the peculiar feature among machine tools of requiring an excess of energy at the instant of reversal. While the demand for excess energy is but momentary, it may amount to as much as five or six times that used by the machine when cutting. This condition is made necessary by the use of reverse belts designed to give a reciprocating motion to the planer table by shifting from tight to loose pulleys. The mechanism provided to shift the belts is designed to snap them into position almost instantaneously. It is essential that this be so, to provide for a sharp and precise reverse with the minimum amount of drifting of the planer table. To render the belts easy to shift they are kept to a narrow width and then run at a high linear speed to give the necessary power. This leads to a condition as follows: a set of driving pulleys running at a high rim speed which must be brought to rest and then accelerated to a high speed again, but in a reverse direction at the instant; and it is this shock of reversal that calls for the excess energy previously referred to.

To learn something of the conditions which obtain when an induction motor is used to furnish the power to drive a planer, a series of tests were made with the 10 horse-power motor used to drive a 36x36-inch by 10-foot planer. The object was to determine what would be the effect upon the power consumed (1) by changing the length of stroke, and (2) by the use of a fly-wheel upon the planer drive. As a matter of good engineering, it was desirable to keep the weight and diameter of the fly-wheel as small as possible, and it was therefore mounted upon the shaft having the highest rotative speed, in this case the motor shaft itself. The design of the fly-wheel was sufficient to store and restore energy to take care of the shock of reversal without material change in the speed of the motor. The duration of tests was extended over several days and when averaged and analyzed showed interesting results. On a planer the capacity of the one tested, the size of the work will usually be such that the planer will be worked at from one-half to full stroke, and the tests were run at one-half stroke for one series and full stroke for the other series. In each series, the readings under the conditions noted were nearly uniform, showing a complete steadiness of running. The problem easily resolved itself into that of a long stroke with a definite number of reversals to surface a given area, and that of one-half the full length of stroke and double the number of reversals to surface the same area. At one-half stroke or 5 feet in length, the full width of the planer was utilized, which gave 2160 square inches of surface to be planed.

Under the conditions of full stroke, one-half the width was used to give an equal area of surface. Table 1 gives the power consumption in kilowatt hours and the per cent. of gain under the given conditions.

It will be noticed that while the greatest saving is made by using a carefully designed fly-wheel properly placed, there is somewhat saved in mounting the work by grouping to give a maximum length of stroke. This accords with the best planer practice and is interesting from that standpoint alone. The price of electric energy was taken at five cents per kilowatt hour as a fair average of rates.

Conditions	Power consumed k.w. h'rs	Per cent. of gain	Cost of power per hour	Net saving per hour
Short stroke—5 feet without fly-wheel.....	1.848	00.0	$0.0924	$0.000
Long stroke—10 feet without fly-wheel.....	1.626	12.0	$0.0833	$0.009
Short stroke—5 feet with fly-wheel.....	1.302	29.5	$0.0651	$0.027
Long stroke—10 feet with fly-wheel.....	1.240	32.9	$0.0620	$0.030

TABLE I

*From the *Journal* of the Worcester Polytechnic Institute.

More Arithmetical Short cuts

By Apollo

I do not think the majority of men realize the amount of time that can be saved by the application of a few simple rules for reckoning in the ordinary calculations that crop up in every-day life. I am pleased to see that some of your readers are taking up this question, and I should like to see the discussion continued.

It is remarkable how few people know how to add up a row of figures properly. I have seen first-class men take longer to add together a dozen figures than a smart school boy would, and, when they had done so, would have to go over it again to convince themselves that it was correct.

The secret of adding quickly and accurately is to know at a glance the sum of any two unit figures; for instance, one glance at $7+8$ should be sufficient to know that the answer is 15. If a table be made out of all the combinations between 1 and 9, and be committed to memory, the speed with which addition can be made will be increased to a remarkable extent. It is almost needless to show that if the sum of 9 and 8 is known without hesitation, then the sum of 79 and 8 can be obtained equally as quick.

Anyone who has seen an accountant at work is struck with the rapidity with which he adds up long lists of figures, and it is needless for him to go over them twice; he knows that his answer is correct.

Mr. Shaw's method of squaring numbers is the one I always use, but I do not know whether it is better than the one shown by F. H. C. I should, however, like to point out a much simpler method when the units figure is a 5.

To square a number consisting of two figures, the unit figure being a 5:

Rule—Multiply the number preceding the 5 by one more than itself and annex 25.

Example:

$35^2 = 3 \times 4 = 12$, annex $25 = 1225$

$95^2 = 9 \times 10 = 90$, annex $25 = 9025$

This, I think, is simplicity itself. When the tens figure is a 5, the following rule is almost as simple:

Rule—Square the tens figure and add the units figure, call the product hundreds, and add the square of the units.

Example: $52^2 = 5 \times 5 = 25$, add unit $= 27$; then add unit squared $= 2704$.

$59^2 = 5 \times 5 = 25 + 9 = 34$; answer $= 3481$

It is usually more useful to be able to multiply two figures together than it is to square them, for the squares can be obtained from a pocket-book, and the product is more often required than the square.

The following is an extremely simple rule to multiply any numbers between 10 and 20:

Rule—Multiply the units, set down the right-hand figure in the product, add the carrying figure (if any) to the multiplier, and the right-hand figure in the multiplicand, set down the sum.

Example: 18×16, $6 \times 8 = 48$; set down 8. Add, carrying figure 4 to $16 = 20$, also the 8 in $18 = 28$; answer $= 288$.

$19 \times 13 = 3 \times 9 = 27$; set down 7. Then $2 + 19 + 3 = 24$; answer $= 247$.

This may look rather long, but with a little practice the product of two figures can be obtained mentally almost at once. It is one of the most useful rules I know, as it enables anyone to carry in his head a multiplication table up to 10×20.

Another simple rule is for multiplying a row of figures by a number consisting of nines.

Rule—Annex as many ciphers as there are nines in the multiplier and subtract the multiplicand.

Example: Multiply 374682 by 999.

374682000

374682

374307318

Answer $= 374307318$.

The foregoing rules may seem long on paper, but when they are once committed to memory and practiced a little, it is surprising how much time can be saved, as it is often not necessary to use pencil and paper, and it is quite mystifying to anyone you happen to be talking to.

I hope we shall have some more short-cuts from other of your readers, perhaps some simpler than I have tried to show.

Spherical Bearings with Few Tools

How a Lathe and Boring Mill Were Rigged Up to Handle a Difficult Job and the Good Results That Were Obtained

BY M. R. LATHROP

I would like to describe an odd job that was put up to me last year. The accompanying sketch shows the work. The tools we had were a 48-inch planer, a 33-inch lathe, a 5-foot radial drill, and a 5-foot boring mill.

The first work to be done on these castings was planing, which was accomplished after building out the tool post on the planer about 3 feet.

We then blocked the head of the 33-inch lathe up 12 inches and turned it end for end, so that the face plate hung out over the end of the lathe. Then we placed the boring bar and holder on the face plate and supported the free end of the bar in a bearing bolted to a large platen, which we had on hand. This was bolted to a wooden table, which was lagged to the floor. Then we rolled the casting in between the lathe and platen, and after some trouble got it set just right. The floor was not built for that kind of a job, and sagged about ⅜ of an inch. Fig. 2 shows the casting in place and the lathe blocked up.

The lathe, casting and platen were bolted together by angle irons.

Finishing the Outside of Bearing

To finish the outside of the bearing a compound rest was taken from a small lathe, and mounted on a large cast-iron arm, which was bolted to the boring bar, as shown in Fig. 3.

I had read of large spherical bearings, but had never seen any, and to bore this bearing I found we should have to make a special rig. Having seen a description of the boring bar used for that purpose by the Allis-Chalmers Company, thought that a copy of that on simpler lines would do.

We had a 5¾-inch boring bar 5 feet long. This we spotted near the center on each side, drilled and tapped it for two trunnion bolts. Then I had a collar cast, which can be seen in Fig. 2, and mounted it on these trunnion bolts. This collar, with a ½-inch hole on the outside for a cutter to be held by a set-screw, made a tool that would describe a curved surface if properly fed. To do this I connected the collar to a sleeve that would slide freely on the boring bar by a link. The sleeve was tapped 1 inch with a 16-thread, and a screw 12 inches long fitted to it. Fig. 2 shows this also.

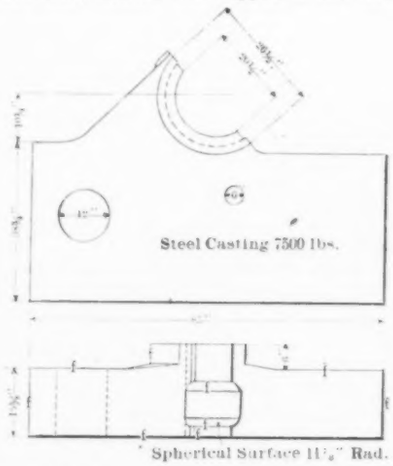


FIG. 1. THE HOUSING WHICH HELD BEARING

Boring a Spherical Bearing

A bearing was turned on the other end of the screw, leaving a shoulder and a thread cut on the extreme end for a nut. A piece of 1¼-inch square stock 6 inches long, was then drilled to receive the bearing of the screw. The nut was tightened enough to take up all end motion, yet leaving the screw free to turn. This piece was then driven tightly into a slot in the bar.

The screw then being entered in the tapped hole of the sleeve, I found I had a feed which would give me a swing on the collar of about 80 degrees. Fig. 4 shows plainly this rig in position, but with the cap of the bearing removed. A machinist gave this screw a slight turn with a wrench at each revolution of the bar.

Then the spherical bearing was bored without any trouble from chatter, the device working much better than expected.

The 6- and 12-inch holes shown in the sketch were then laid out and bored under a drill press, using a boring bar with the lower end supported in a bearing bolted to the base of the drill.

Turning Outside of Boxes

The boxes to fit this spherical bearing were finished on a 5-foot boring mill, the last operation being the outside. The method used by the Allis-Chalmers Company being too expensive for us, as we never expected to repeat the job, we resorted to a makeshift.

A segment of steel ¾x2 inches was turned on the inside to the radius of the box, and bolted to the column of the bor-

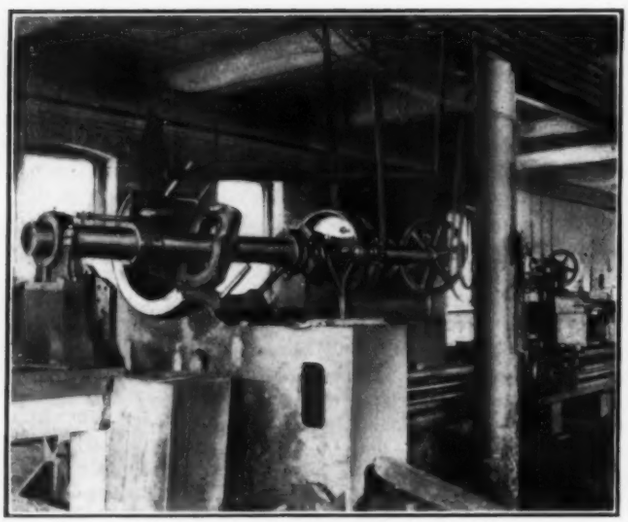


FIG. 2. LATHE BLOCKED UP TO USE FOR BORING MILL

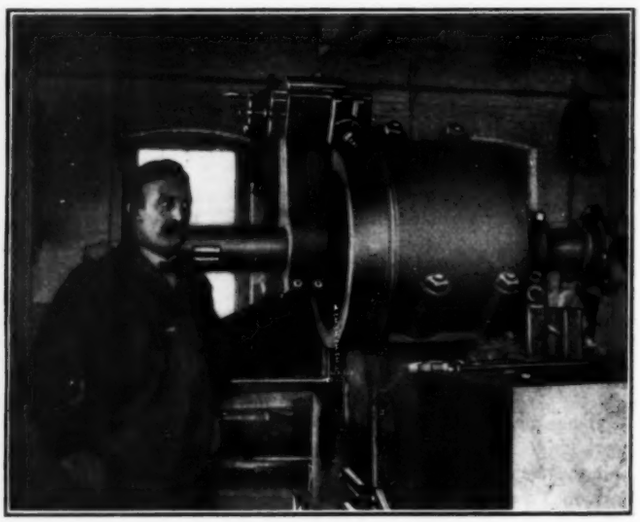


FIG. 3. FACING AND TURNING OUTSIDE OF BEARING

ing mill, as shown in Fig. 5 by means of two angle irons.

After finding the exact hight of the center of the spherical bearings, a corresponding center line was made on the segment. A small round-nose tool was then put in the tool post on the side next the work, an indicator being put in the other side of the post with the contact point the same hight as the center of the tool; the center of the tool was then placed the same hight as the center of the bearing, and the right distance from the work to take a chip.

Using the Indicator

The contact point of the indicator was then adjusted to touch the segment at the same hight, the pointer marking zero on the dial. The center of this bearing being cut away, as shown in Fig. 5, we moved the head of the boring mill in a little way, and moved the bar down by hand until the tool was close to the work. Then the head was again drawn out until the pointer on the indicator again marked zero, when the down feed was thrown in and the boring mill started.

The machinist stood with his hand on the handle of the cross-feed screw, and, watching the indicator closely, could, by moving this handle slightly keep the pointer on the zero mark.

And this, as can be plainly seen, caused the tool in the tool post to form the same arc as the segment. In Fig. 5 the indicator does not show, on account of the edge being toward the camera. This use of the indicator was new to me, but finished the job both well and cheaply.

The Test of Accuracy

There were two of these castings, made right and left, and when completed they were placed side by side on a large platen and lined up by the outside. After trying the alinement of the spherical bearings, both 6- and 12-inch holes, the greatest error was found to be 1/64 inch, which was quite within the limit of dredge work. These castings were the upper tumbler and ladder bearings of a large dredge used in gold mining in Montana.

I have read with great interest in the American Machinist about unusual jobs and hope that this one may be of interest to others.

The Technical Graduate from a "Practical Standpoint"

By Perseveri

"Instructor's" letter, on pages 152-3, is, I think, highly amusing in parts.

Now take the case of the student whose approximation was about 75 per cent. "Instructor" admits that he impresses, or tries to impress, upon his students the fact that the solutions of some problems need be approximate only, and he groans because one of his students takes his advice too literally. To my mind the fault lies with "Instructor" himself. He should make a bigger or better impression; but if he cannot do that in the case of a particular student, it seems hard that the others should suffer for that student's denseness, as they undoubtedly would if he dropped approximate methods altogether.

Again, why dare not the average professor allow his students to realize that there is a region of doubt and disagreement beyond our fixed knowledge?

If the hard time served by "Instructor's" students is confined to merely "a year or so," they are lucky and their teacher has cause for congratulation.

The admission that students graduate under the impression that they have covered the entire field of engineering, simply gives the whole show away, and that they largely get this impression from the professors is proved when "Instructor" says that it takes a lot of nerve to tell the boys that one does not know a lot of things.

It is hardly correct to say that they have nibbled round the edges, the process being more like taking a few deep bites here and there. The man who has conscientiously nibbled all around the roots will at least have chewed off sufficient of the tree of knowledge to form a sound basis for the structure which can be built only of material got first-hand in the shops.

Taking "Instructor's" figures, namely, that a student may have taken 40 different subjects, and that he may eventually find himself up against any one of 1000 different jobs, it is plain that the chance of one of his subjects being included in the 1000 is exactly 25 to 1.

Now these are decidedly long odds, considering that the poor misguided student is forced to be the taker. In the event of one of his subjects proving a real winner, the gambling instinct, said to be latent in every human being, might assert itself in other directions, with disastrous results.

Neither "Instructor" nor anyone else can train a boy so that he will be able to immediately handle any job that comes along, and the sooner teachers get a tight hold of this fact the better. That "Instructor" knows the right lines is evident when he says that it is possible only to train the boys in the underlying principles, but the point is, does he act, or is he allowed to act, up to his better judgment?

On the question of what should and what should not be taught in technical colleges, and of the order of importance of the usual stock subjects, there are opinions without end.

The present practice seems to be to get the student onto so called "practical" problems straight away, with the final result that theory and practice are all jumbled up together. Of course, it may be urged that interest in the subject must be kept up, but it seems to me that the boy who requires this sort of kinder-

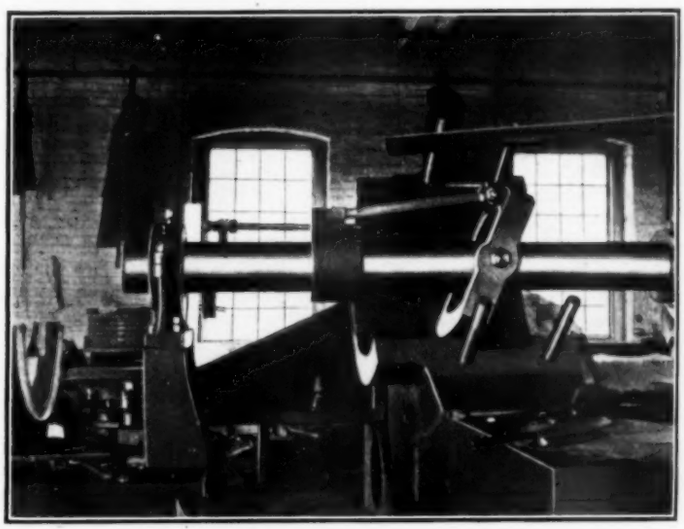


FIG. 4. DETAILS OF SPHERICAL BORING BAR

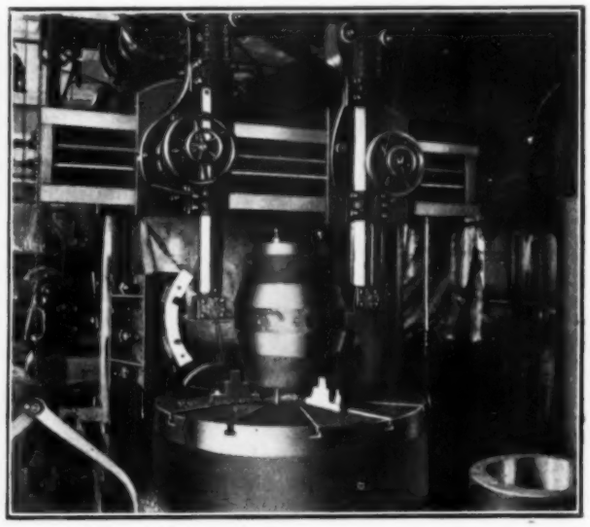


FIG. 5. TURNING OUTSIDE TO FIT SPHERICAL BEARING

garten business to keep him keen would be better out of it altogether.

The painful experience of an alleged technical education leads me to believe that the present system is radically wrong. Instead of being a rigid specialization in certain subjects on new lines it should be largely a continuation of the ordinary school course with special reference to the subjects pertaining to engineering in its broadest sense.

First and foremost the habit of thinking logically and independently should be cultivated, and there is no better way of insuring this than by working out problems in Euclid.

In the light of modern methods this might be looked upon as a retrograde step, and a waste of time, but I consider it will do a student a great deal more good than standing by a testing machine, time after time, watching innumerable specimens being broken, and that without considering the time wasted in most colleges by the students in making the test-pieces.

A thing in which most engineers are woefully lacking is a knowledge of foreign languages, and it seems to me that technical French and German should be made leading features. It is not necessary that the students should be able to speak or write these languages well, but they should be able to read them fluently.

Another saddening feature is the almost total disregard paid to current technical literature.

An hour or two per week, spent by the professor, in company with his students, in glancing through the pick of the weekly and monthly magazines would be time well spent.

I think that I have indicated, though somewhat briefly and roughly, what I consider to be some of the failings of the present system and "Instructor's" comments would certainly be interesting.

Iron and Steel Industry in Australia

Consul-General John P. Bray reports the formation in Melbourne of two companies, one with a capital of over $2,500,000, for the manufacture of iron and steel in Australia.

One company is to operate at Lithgow, in the State of New South Wales, where large deposits of magnetic, hematite, and other iron ores, together with coal and limestone, are said to exist; the other is to be located near Melbourne, the ore being brought from the Tamar river, Tasmania. In both cases large plants are to be erected and the whole of the machinery to be of an up-to-date type. These companies are the first serious attempts to establish the iron industry in Australia, though the local manufacture of at least sufficient iron and steel for the requirements of the Commonwealth has long been advocated by those interested in the subject.

A Symbol System for Machine Parts

By A. L. Pratt

Among the complexities of a large machine-shop organization there is no one detail of system more important than the designation of the parts manufactured. This is especially true if the shop makes many thousand different pieces.

In regard to shop records it is in the catalogs, manufacturing orders, raw-material requisitions, work in process records, finished-part records, piece-work contracts, cost-department files, shipping records, inventory, selling-price lists, and so on. It is a vital part of all such records and may enter any particular one an almost unlimited number of times in connection with a manufacturing lot of parts and during a short interval of time. Thus its importance can be appreciated.

I was at one time employed in a machine shop which manufactured and carried in stock over 50,000 different kinds of parts. The business was the result of consolidations, and several systems of designating parts were in use. One was a numerical series from 1 to about 10,000; another was a number accompanied with letters indicating a machine; another used a number, letters after the number to indicate the machine, and a letter before the number to indicate a certain group of parts forming a particular motion. In some cases fractional numbers were used. Letters were used following numbers and separated by a dash, read in the shop parlance *minus*. Numbers were used in combination in the same way. As the business grew, the complications increased and symbols having eight and even nine characters were not uncommon.

It is my purpose to outline a simple system of symbols which will embody all the essential requirements for general machine-shop use. Such a system must have consistency, simple characters, a limited number of characters in a symbol, individuality for each symbol in appearance and sound, and as large a number of symbols as possible.

Proposed System

Nothing but figures and the letters of the alphabet is to be used, omitting the letters *B, C, E, J, M, O, Q* and *V*. Not over five characters are to form any one symbol. One series of symbols is consecutive numbers from 1 to 99,999 inclusive. The other series, 18 in number, is a combination of a letter of the alphabet and numbers from 1 to 9999 inclusive, as *A*1, *A*2 ————*A*9998, and *D*1, *D*2————*D*9998.

The letters listed above as omitted are left out because they resemble some other letter in sound or appearance, either when seen in a normal position or upside down; for a number on a part is just as liable to be first seen in a reversed position as in the other. For instance, *B* resembles *R* in appearance and *P* in sound; *C* resembles *G; E* resembles *F* in appearance and *D* in sound, and so on. Certain numbers, combinations of 0, 1, 6, 8 and 9, are not to be used. Combinations of 6 and 9, as 66, 999, 696, which can be read as a number when reversed, are to be excluded. This reason holds good for all these eliminations of numbers. Combinations of 0 and 1, as 1011; of 0, 6 and 9, as 606, 6096; of 0, 1 and 8, as 108, should not be used. In fact any combination of 0, 1, 6, 8 and 9 which will read a number when reversed should be avoided. This need not apply to a few cases like 101, 609, etc., which read the same in either position.

The liability of mistaking a number is real, for the letters and figures cast on machine parts, or stamped, are not, in general, as sharp and clean cut as a superficial examination might lead one to expect; and it is some of the imperfectly formed symbols which will cause trouble, especially if they can be read in both the normal and reversed positions. For while a figure 8 has a distinct feature determining its position, as the lower portion is slightly larger than the upper, this identity is often lost in cast and stamped figures.

The total number of symbols is large, large enough probably for several generations of machine builders in a particular line. There are 19 series aggregating nearly 280,000 symbols. Allowing 10 per cent. for those eliminated, there would still be a quarter of a million available.

The elements of such a system, as laid down earlier in this article, are met by the proposed plan. It is consistent; its characters are simple, letters and figures; the characters in any one symbol are limited to five; each symbol has individuality when spoken or seen in any position, making it difficult to be misunderstood; and it has extent, with nearly 250,000 separate symbols.

The first series of numbers is large, having perhaps 80,000 symbols. The others are shorter, containing 9999 each. If desired, a classification of the parts can be made by using the different series for parts to be grouped together. Such a course would perhaps be of doubtful benefit in the long run.

It may be urged that one point of efficiency is sacrificed; the connecting of parts of the same machine or motion by some common character. While this is true, to my mind the loss is small. A part is often used on several machines, and loses all identity, as far as the original machine for which it was designed is concerned.

The essential point is to individualize the designation of the part itself in a simple and systematic manner. I believe the proposed system will accomplish this result.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Increasing the Output of a Horizontal Boring Machine—A Facing Head

When the superintendent intimated that he would like to see more work coming from the large floor-plate boring machine, I explained to him that, if he would allow me to make slight alterations in the machine, I was satisfied he would get at least 25 per cent. more work; he said to go ahead.

The horizontal machine has been in use a number of years, and was one of the first manufactured of the now quite common but much improved horizontal floor boring machines. The original spindle of the machine was of a length as marked in Fig. 2, and this of a necessity compelled us to clamp facing heads upon the boring bar when facing any and all work, quite an unsatisfactory proposition, and also a time consumer, as of course no boring could be done while facing was going on.

This facing head and spindle I think will be appreciated by some of your many readers, as it was designed and used as a permanent machine part and was not removed, as it was in nowise in the way. I know there are many such machines in use.

Fig. 2 is an end elevation of the machine spindle and facing head. The slide-supporting ribs are shown. It will be noticed that the part clamping the facing head to the spindle is hinged on the left side, while an eye-bolt of ample strength, with eccentric *A* in the eye, connects the other side. The device is shown as clamped to the spindle. Dotted lines *B* show the position of the eccentric lever when the facing head is unlocked. A piece of ¾-inch pipe is used in connection with the eccentric lever. When unlocked, the facing head hangs down below the bar at rest, an arrangement (not shown) keeping it in this position, and the spindle being free to run. The lower or clamping part of the head is babbitt-lined where coming in contact with the spindle. This prevents excessive wear upon the machine spindle. Oil holes are provided in the clamp, as shown.

Fig. 3 is a side elevation. *D* is the machine spindle. *E* is the sliding boring bar. The eccentric and clamping bolt are shown, and the section at the lower left-hand corner shows the babbitt in the clamp as well as the contact angles upon the machine spindle and facing head.

The Inclined Clamping Surfaces

Experience with other boring machines has taught me that a round surface to clamp a facing head to is unsatisfactory.

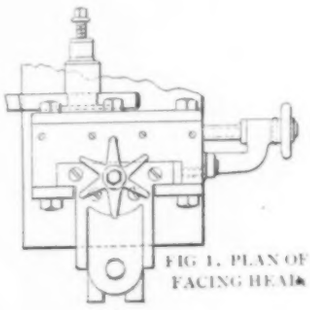


FIG. 1. PLAN OF FACING HEAD.

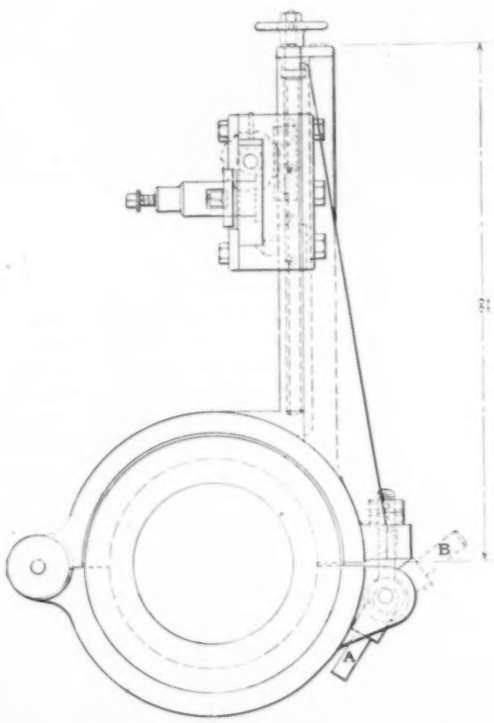


FIG. 2. END ELEVATION.

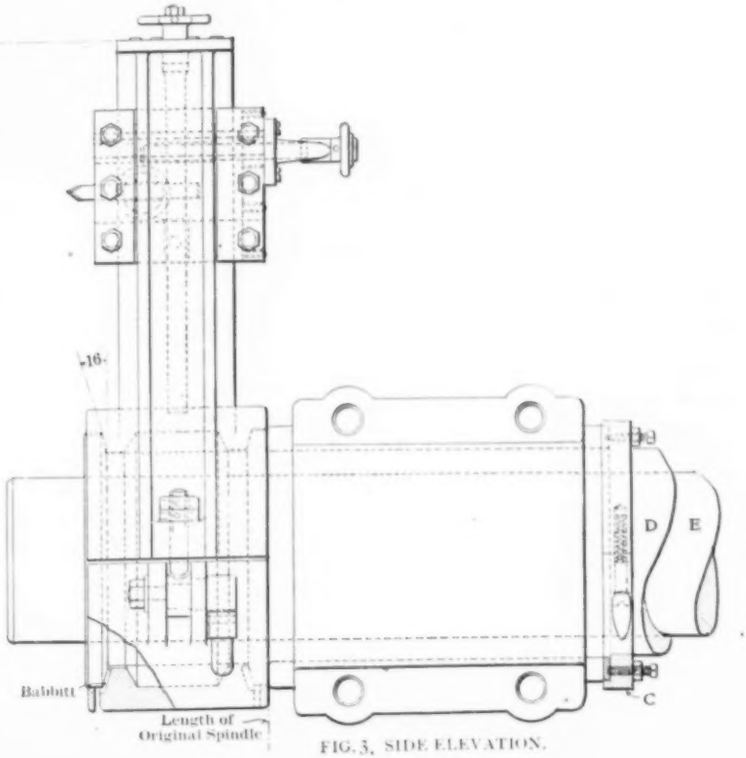


FIG. 3. SIDE ELEVATION.

To get sufficient driving friction the facing heads would have to be clamped so tight as to crush or flatten the machine spindle so that the boring bar could not be moved endwise. The 16-degree angle at spindle and facing-head contact overcomes this. It will be noticed that this facing head has no bearing at the periphery of the machine spindle flanges; neither has it a bearing in the bottom, but upon the sloping sides of the flanges only, while the clamp has a bearing upon the flanges as well as on the angles.

Fig. 1 is a top view of the facing head and shows the rib support for the clamping-bolt lug. The tool adjustment is also clearly shown.

The construction of the spindle, as in Fig. 3, was a pronounced success, as I do not recall having the machine operator crushing or flattening the machine spindle when clamping the facing heads for use, the angles bringing an end strain instead of the excessive crushing strain.

The Take-up for the End Thrust

In Fig. 3 the front journal of the machine is shown (journal cap removed). This is so that the end-thrust take-up, as applied by me, could be shown, the machine originally having no means for taking up lost motion, depending upon the spindle collars only. The cast-iron collar *C* is made in two pieces, tongued and grooved together, and held together with fillister-head screws as shown, and was let into the spindle ⅛ of an inch. Through the collar *C* are twelve 5/16-inch adjusting screws, having turned ends that enter into and against a hardened and ground steel ring (also in two parts), the ring running with the spindle and collar and against the journal brasses. A cast-iron guard covers the collar and adjusting screws. This made a very satisfactory take-up arrangement.

The outer or floor-plate column was fitted with an arrangement the same as that shown in Fig. 3, excepting that the diameters and lengths had to be made to suit the column bearing, and, being driven by the boring bars (splined entire length), necessitated a bushing being made for each size bar (three in number). These bushes had keyways on the outside to suit the floor-plate column sleeve key, and also had a key in the hole made a slide fit for the boring bar.

The Addition of the Facing Heads a Great Improvement

I made, of course, a right- and left-hand facing head, and the boring and facing of both ends of a cylinder at the same time was somewhat of a novelty on this machine.

This arrangement more than justified my promise of a 25 per cent. increase of production on steam cylinders and any work where the facing heads could be used while boring.

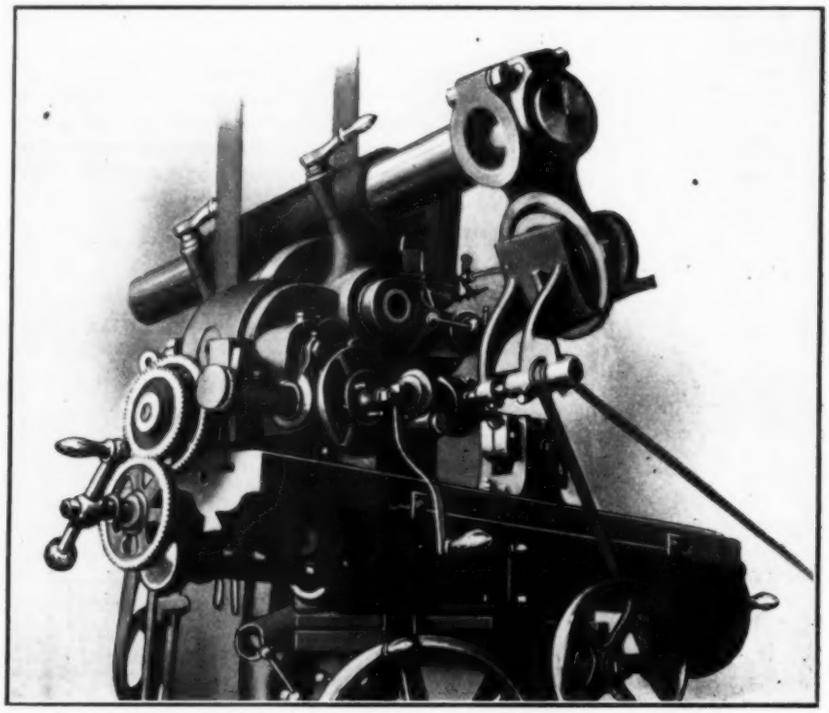
BECK.

Using a Miller to Grind Cams

Recently we had some cams which required particular accuracy, and as they had to be hardened we decided to grind them on the face that the roll bore against on the rise only, as the return was not important.

The cam blanks were about 3 inches in diameter and 6 inches long, and the cams proper about ¾ deep and 1 inch wide at the top, the sides being at an angle of 14½ degrees. The lead was from 1½ to 3 inches on the different cams. After hardening, the cams were swung on the centers of the spiral head of a milling machine which was geared to the correct lead.

The arm of a Brown & Sharpe compound vertical milling attachment was clamped to the overhanging arm of the machine and to this was bolted an internal grinding fixture, belted to a countershaft on the floor at the side of the machine. This was speeded to 12,000 revolutions per minute. The arm was placed so as to bring the center of the wheel on a line with the center of the head. The table was swung at an angle of 14½ degrees to match the sides, and the wheel trued small enough to go to the bottom of groove without touching the other side.



GRINDING CAMS ON THE MILLER

The required feed was obtained by turning the spiral head crank by hand and the depth of cut by moving the cross-feed of the machine.

In this way we obtained a very satisfactory job with a smooth finish. The half-tone shows how it was done.

HART.

Individual Motors for Machine Tools

On page 653 of the AMERICAN MACHINIST, A. L. Pratt speaks of the use of different sizes of motors for the same kind and size of machine tool. It may be of interest to him and to others of your readers to know the conditions in this particular which prevail in the shop where I am employed.

In this shop there are in use twenty-eight 26-inch engine lathes, each having a four-horse-power electric motor mounted above the headstock and driving the machine tool by an intermediate gear of rawhide. Some of these lathes are doing work that a two-horse-power motor would handle easily, while others require much more.

I find that the individual workman has considerable to do with the amount of power required or used by his machine. Let us take for example several machines doing the same kind of work. The first man turns out say five pieces in 10 hours; his motor never gives trouble. The second man turns out eight pieces in 10 hours; he has to call upon the electrician perhaps once a month. The third man turns out ten pieces each day, and is always having trouble with the motor, perhaps burning out an armature or getting a short-circuit, or some other difficulty.

This adds to the actual cost per piece, but it does not appear under that head, being charged to motor repairs.

Another man on this same class of

work does still more than the third one, and although his four horse-power motor has been recently changed for one of five horse-power capacity, he still claims to be short of power.

In view of these facts how would you standardize the size of motors in this particular shop? The fourth man mentioned thinks that a 7½ horse-power motor will be just about right for his work, while the third man has power enough and to spare with the four horse-power motor at present installed. Someone might say, let us strike a happy medium and give them all a five horse-power machine. Let us assume that the second, third and fourth men leave the shop and their places are taken by workmen in the class of the first one. Under these conditions we have a surplus of motor capacity on three of the machine tools. Clearly such a method as standardization would be impracticable.

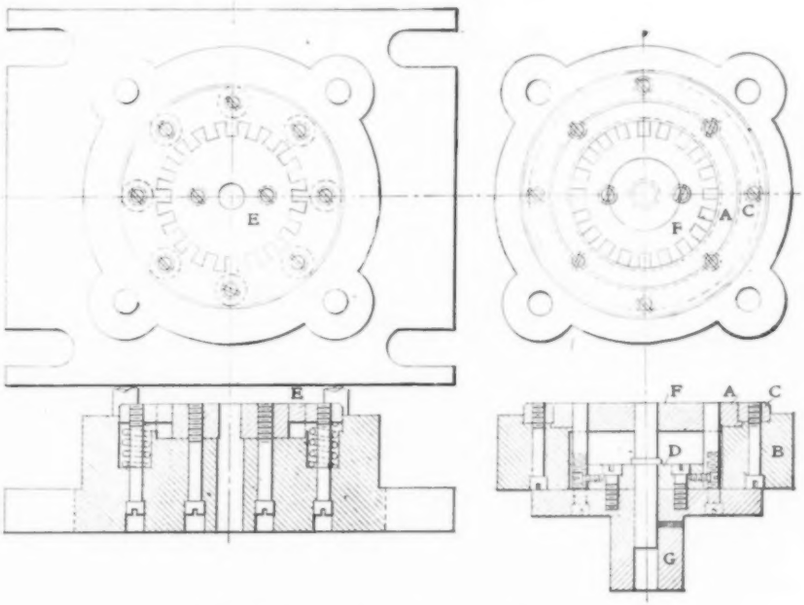
The only way which I can see to accomplish the desired results would be to hire your men, then adapt your machines to the man's individuality and make a contract with him for a long term—say 5 or 10 years. If he is in the class of the first man mentioned, give him a rating of say 35 cents per hour; if he is in the class of the second, third, or fourth man, give him more, and in each case adapt the size of the motor to the man's requirements. In this same connection I would like to hear from others on the best methods of connecting motors to individual machine tools. As I have mentioned we use intermediate rawhide gears. This is not entirely satisfactory for the gears wear very rapidly, and soon become noisy. We have tried silent chains, but they would not stand up to our satisfaction.

A. GREASER.

Compound Die for Small Armature Disks

The cut shows a form of compound die for small armature punchings which I think is an improvement on the one shown by Co-Ordinate, on page 535. The lower part of the die is made practically the same as the one shown by Co-Ordinate, but the upper half is of a quite different construction.

A, the body of the punch, is a plain tool-steel ring ground inside and out, and seated in the cast-iron punch block *B* and held in position by the soft-steel ring *C*. Instead of dovetailing pieces into the ring *A* to form the internal teeth of the punch, I make these pieces in the form of punches which are located in the block *D*, which has slots milled of the same form and depth as the lower die *E* and stripper *F*. The block *D* is fastened to the under side of the shank *G*, so that the center holes line perfectly. Then the stripper *F* is slipped on the punches and the whole is put on an arbor and the outside of the punches is ground to a good fit in the ring *A*. The upper ends of the punches strike against the shank *G*, which prevents them from pushing up; they are held in the block *D* by the screws, as shown.



A COMPOUND DIE FOR SMALL ARMATURE DISKS

The upper stripper is worked by three pins, which go through the shank *G*, and into a block on top, which is operated by the knockout in the crosshead of the press. This is not shown in the cut.

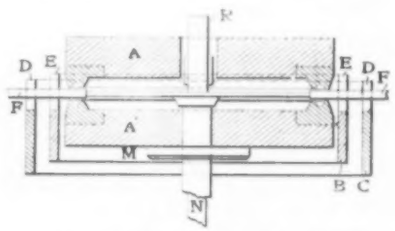
When it is assembled we have practically a solid die without any dovetailing. This dovetailing I consider a bad feature in Co-Ordinate's die. I have made several in this way. They are giving good satisfaction in regard to durability, and they turn out very accurate work.

W. S. M.

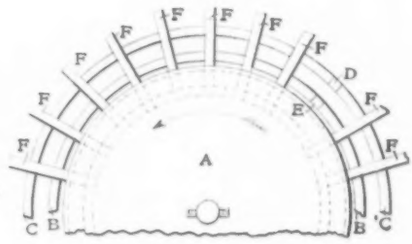
A Rolling Machine for Making Steel Balls

The high degree of perfection demanded nowadays of steel balls for bearings and other purposes throws out of the question the employment of dies, which leave a fin, or of forming tools, which leave either two slight projections or two flat places at diametrically opposite points. Thus the rolling process, using the same principle that the boy employs in making a ball of clay, comes forward. A machine recently illustrated in the *Deutsche Metall Industrie* has for its object the making of a number of perfectly spherical balls at the same time, of equal diameter and finish, from steel rods. The machine is English, and the name of the inventor or manufacturer is not given by the journal mentioned.

The cuts show only the essential parts of the machine. There are two disks *A* and *A'* arranged like millstones, both rotating, but in opposite directions. The vertical shaft *N* bears a heavy collar *M* and the disk *A'*. This lower disk is fast on the shaft, while the upper one is keyed to its shaft *R*, but can move up and down thereon. Both disks are of cast iron, and each has at its rim a steel ring with a groove of exactly semicircular cross-section, so that when the disks touch, the grooves together give an absolutely circular cross-section. The edges of the steel rings are sharp, so that the tendency of the disks when rotating is to cut off the rods *F* which are thrust radially between them. The rotation of the disks serves not only to cut off from the rods cylindrical pieces of a length equal to their diameter, but to roll and to compress them, thus shaping the cylinders into spheres of greater density. Where no compression is required, or from the nature of the material none is attainable,



SECTION OF BALL-ROLLING MACHINE



PLAN OF BALL-ROLLING MACHINE

the diameter of the rods must be calculated so that the cubic contents of the portions cut off shall exactly equal a perfect sphere.

The vertical slits *D* and *E* in the cases *B* and *C* permit the rods to drop down as the upper disk falls in cutting them off. As soon as the two disks touch, electric contact is made, and the machine is automatically stopped. The disks are then separated, the upper one being raised by means of a lever provided for that purpose, the balls are removed from the grooves, and the rods again inserted for another lot. The balls thus manufactured are said to require no further machining. The machine can also be used for such parts as machine handles, etc., by having rings with the proper shape of groove.

ROBERT GRIMSHAW.

Hannover, Germany.

Fine Adjustment of Tool Block

Full particulars of the construction of the tool rest to which Conrad has applied the fine adjustment described at page 532, designed to locate the tool block to within an amount equal to 0.0005 (half a thousandth) or less, would be welcomed, by the present writer, at least, if not by many manufacturers who have had this problem before them. Led Conrad apply an indicator to the tool block and see how he can spring the dead stop by ever so small an amount of energy applied at the main screw. He will have afforded him a clue "why some method like this has not already been adopted on engine lathes."

Referring to the sketch at page 532, the supplementary bush screw increases the adjustability two to one over a single screw properly graduated and of a suitable pitch—say 50 graduations, and 20 per inch. The diameter of the graduated part, however, being only about half that of the single screw, makes the spaces between the graduations so small that subdivision, on account of confused vision, would be more difficult.

Possibility of error due to the need of holding one screw while turning the other, and the extra time required for the double setting, must not be forgotten.

What is really needed is some method of adjustment independent of the dead stop, and the only way I know is the good old-fashioned one of applying to the feed screw itself a finely graduated disk of comparatively large diameter. A screw 5 threads per inch, with disk 3 inches in diameter, having 200 graduations to the complete circle, would give lines 1/20 of an inch apart and afford an adjustment of 0.001 (one-thousandth) without subdivision. A useful form of disk is one connected to the screw frictionally, enabling the disk to be set back after each cut, to zero, so saving the nerve strain attached to remembering the last position of the disk.

FRANCIS W. SHAW.

A Press Job—Indenting a Tube

In the sketches which accompany this it is intended to show how we did the indenting of the tube shown in Fig. 1; it will be seen that it is indented on both of its flat sides.

Fig. 1 A is a side elevation of the indenting tools, shown for sake of clearness in partial section.

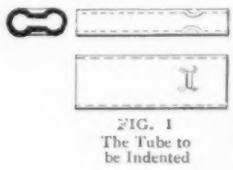


FIG. 1
The Tube to be Indented

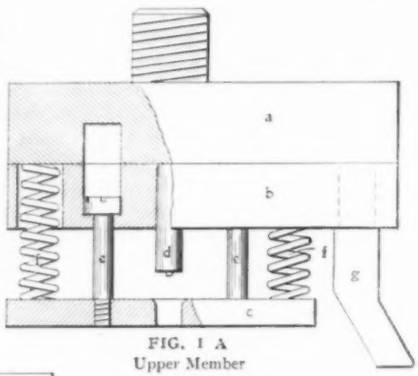


FIG. 1 A
Upper Member

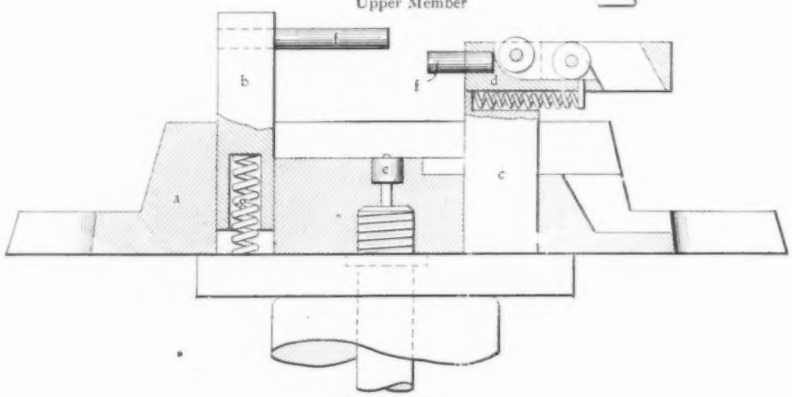


FIG. 1 B
Lower Member

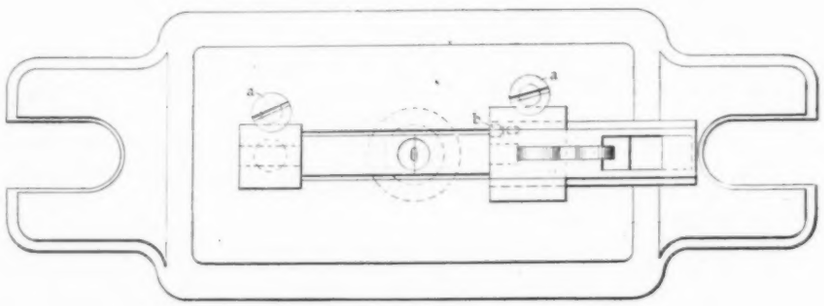


FIG. 2. PLAN OF THE LOWER MEMBER

the indent, *g* is the leg or cam which actuates the sliding member *d*, Fig. 1 B.

In Fig. 1 B, *a* is the bolster of gray iron slotted out for the sliding parts *b* and *c* and machined out for the work in the center; *e* is the die or punch which makes the lower indent; *f f* are the two mandrels on which the tube is held while the work is being done. Beneath the bolster will be seen the usual rubber buffer and buffer plate, together with their supporting pin. The lower ends of these are not shown. The mandrels *f f* are fixed in their respective holders simply by their shanks being driven in; *d*, Fig. 1 A, and *e*, Fig. 1 B, are force fits in their holders.

Fig. 2 is a plan of the die.

Fig. 3 is an end elevation of punch and die, and Fig. 4 is a side elevation of punch and die in partial section, shown at the closed position with the work in place.

A few words will suffice to explain the tools. Referring to the punch, Fig. 1 A, *a* is the punch holder, *b* the punch pad, *c* the pressure plate held in position by the two pins *e e* and forced down by springs *f f*; *d* is the punch for the upper part of

Referring to the plan, Fig. 2, two screws *a a* will be seen which serve to retain the slides when the press is at the top of its stroke. A similar screw *b* also serves to retain the slide *d* in slide *c*, Fig. 1 *B*.

Description of the Operation

To operate the tools the tubes are placed by the operator on mandrel *f*; the press is then tripped, the punch descends, and pressure plate *c* comes in contact with the upper end of slide *b*; the latter is forced down till it is in line with the other mandrel carried by slide *d*, which in turn is carried by slide *c*; continuing the stroke, slide *d* is moved inward until the two mandrels are in contact with each other. The female part of the indent is formed on the two mandrels at their point of contact, thus allowing of their ready extraction.

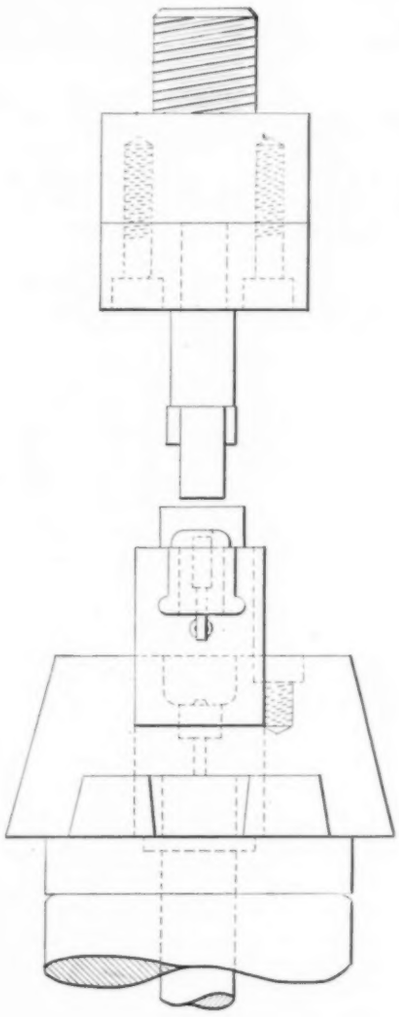


FIG. 3. END ELEVATION OF TOOLS

Referring to Fig. 4, it will be seen that after the mandrels come into contact there is a slight dwell on the leg or cam *g*; this insures the mandrels being retained in correct relation while the indents are being formed. When the punch rises the mandrel *f* is withdrawn by its slide, leaving the indented tube on the other mandrel, to be taken off by the operator.

PRESSTO.

The "Runnerless" Slide Rule

At page 256, Vol. 29, Part 2, you kindly mentioned the little pamphlet, "The Runnerless Slide Rule," and I was pleased to learn that you fully agreed with me that the original arrangement of scales is far more convenient that the Mannheim arrangement.

The Runner Retained as a Convenience in Certain Circumstances

The objection that you would not discard the runner, as you found it useful in continuous multiplication and divsion, is the one objection I have met quite often, and I have therefore decided to furnish a runner with every rule, although it has been my invariable experience that engineers use it only in the beginning from habit and discard it as soon as they find that it is not a necessity but only a convenience. In fact, in many cases it is an actual hindrance, as it obscures part of the graduations of the rule and thereby interferes with reading the value of the line in question.

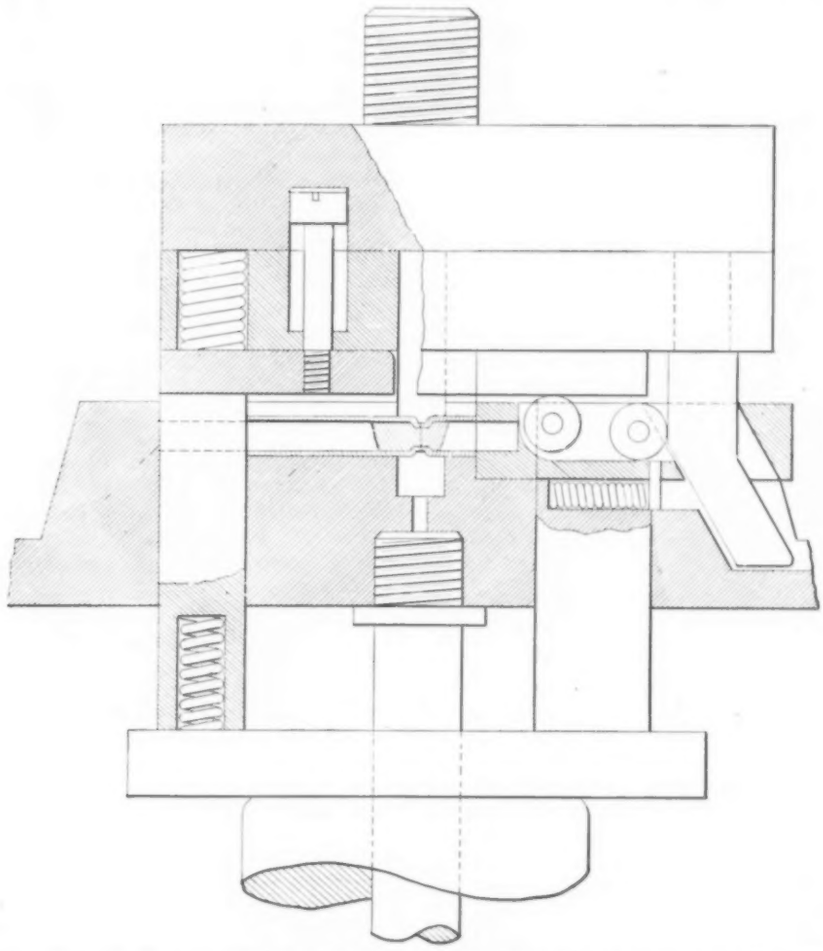


FIG. 4. UPPER AND LOWER MEMBERS CLOSED TOGETHER WITH WORK IN PLACE

Methods of Expressing the Various Applications of the Slide-rule

As far as I know, the method of writing the slide-rule formulas explained in the booklet is new and original. The first one to systematize the slide-rule formulas was R. C. Smith, then chief engineer of Otis Bros. & Co. He numbered the different scales, starting at the top, 2, 1, 4, 3, and developed his formula according to the following two schemes:

Formula 1: $a\ b\ c\ d$ Formula 2: $a\ b\ c^2\ d$
Scales: 1 2 1 2 Scales: 1 2 3 4

The mathematical formulas were then:

Formula 1. $\frac{a}{b} \times d = c.$

Formula 2. $\frac{a}{b} \times d = c^2.$

A Set of Three Formulas

After a short use of these formulas I found that an improvement could be made by putting the terms in the shape of a proportion, and I added a third formula, using scales 3 and 4 only, which proved to be the most valuable of all. I also changed the notation of the scales, starting at the top, to read 1, 2, 4, 3, in conformity with the terms in the proportion.

Formula 1.

Formula 2.

The three formulas were then as follows:

Propositions.

$a:b = c:d,\quad a:b = c^2:d,\quad a^2:b = c^2:d$

Scales.

1 2 1 2, 1 2 3 4, 3 4 3 4

THE ANSWER TO ONE EXAMPLE IN EACH CASE AT ONCE EVIDENT, INDICATING THE DECIMAL POINT

Writing the formulas in this form, it is immaterial which quantities are known and which quantity is asked, the same formula holds good in either case. But there is another advantage which is most marked in the use of the third formula.

Namely, if for example a, b and c are known, we see at once (referring now to the third formula) that if $c = a$, then $d = b$, and we have the answer for one case correctly, and this answer furnishes the means of locating the decimal point without the necessity of observing which end of the slide projects.

To make my meaning clear I will select the problem of finding the contents of a cylinder when diameter and length are given. The following formula will be used for this:

Proportion $4.95^2 : L = d^2 : G^*$

Scales 3 4 3 4

in which L = Length in feet,

d = diameter in inches,

G = U. S. Gallons.

This formula means that if $d = 4.95$ inches, then $G = L$; or, if $L =$ say 152 feet, we know that a cylinder 4.95 inches in diameter, 152 feet long, contains 152 U. S. gallons.

By means of scales 3 and 4 it is now easy to find the contents of a cylinder of any other diameter. Set 152 on scale 4 over 4.95 on scale 3 and over diameter find contents in gallons. Thus we can read off an indefinite number of answers as follows:

4.95	inches diameter	152	gallons
4	" "	100	"
2	" "	25	"
6	" "	225	"
8	" "	400	"
10	" "	625	"

This setting covers all diameters from 1.265 to 10 inches. Other diameters can be formed by multiplying or dividing by 10, then the contents must be multiplied or divided by 100.

Thus we find:

4.95	inches diameter	152	gallons
0.495	" "	1.52	"
0.5	" "	1.56	"
0.75	" "	3.5	"
or,			
4.95	" "	152	"
49.5	" "	15200	"
25	" "	3900	"

I trust that I have made clear to you the great value of my method of writing the slide-rule formulas, which is commented upon and emphasized by all users.

F. F. NICKEL.

*The constant

$$4.959 = \sqrt{\frac{144}{0.7854 \times 7.48}}$$

—ED.

How to Check Nuts

I show herewith a few more ways that have proved satisfactory for locking nuts.

Fig. 1 shows a method of locking a piston-rod nut for a tandem engine. A copper washer is slightly peened into the holes as shown, so that when the nut has been screwed down it prevents the washer from turning around and the nut is locked by riveting the washer up against its sides.

Fig. 2 is a crosshead nut provided with a lock which fits the outside of the nut, so that by tightening the cap screws the clamps hold the lock and nut in any required position.

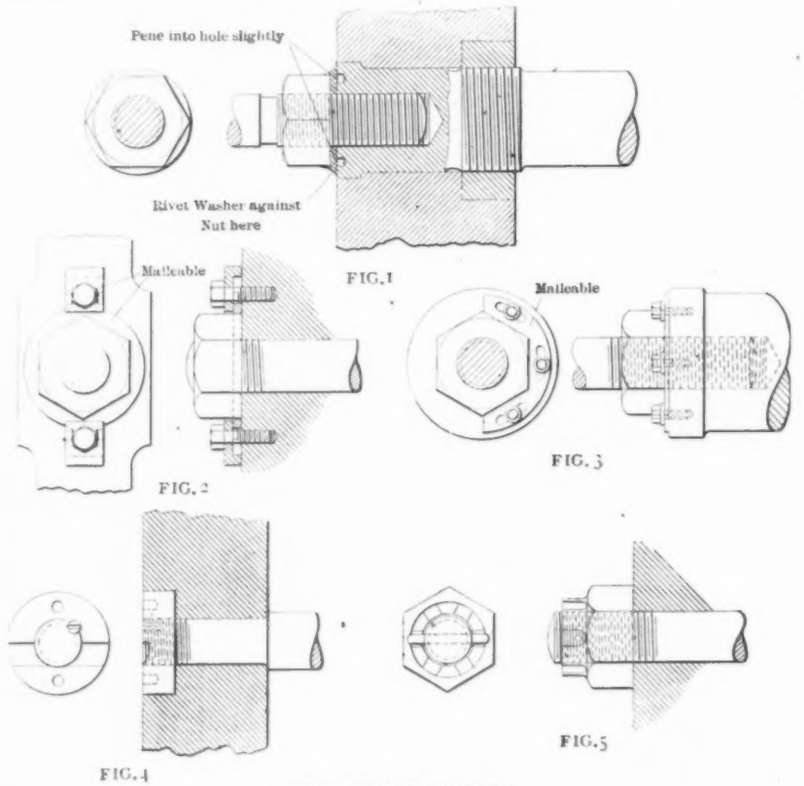


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

MORE CHECKS FOR NUTS

Fig. 3 represents a somewhat similar method of locking a crosshead nut. The lock in this case is provided with slots so that it may be adjusted to agree with the sides of the nut and is held in place by cap screws, which prevent the nut from coming off.

Fig. 4. After the piston rod shown has been pressed into the piston the nut is screwed down with a spanner and tightened by a set or cold chisel with a blunt end being placed in the slot shown and driven around with a hammer, as it would be practically impossible to tighten the nut sufficiently with a spanner. A small hole is then tapped in the joint as shown and a headless screw is inserted which prevents the nut from coming off.

Fig. 5 shows a nut much used in agricultural machinery. This nut is provided with lugs so that when the nut has been screwed down, by drilling a small hole through the bolt between these lugs, a pin may be inserted which prevents the nut from coming off. W. S. BRODEUR.

Packing Machinery for Export

In the many articles you have published from time to time about packing machinery for foreign shipment I have seen no mention of a feature practiced by the Straight Line Engine Company, which is the packing of all small parts in old oil barrels.

A barrel is the easiest of all things to handle, cheaper than a well-made box of the same capacity, water, fool and burglar proof, and it will stand more abuse than a package of any other sort.

With some concerns old oil barrels are looked upon as worthless; in our locality they are credited up at $1 each.

JOHN E. SWEET.

In order to keep the St. Lawrence river open for navigation during the winter an ice-breaking steamer 172 ft. long by 32 ft. beam has been built in England for the Canadian government. The normal draft is 12 ft. and the displacement 1055 tons. The bow is formed to mount and break through the ice, and the frame is strongly reinforced to resist the pressure. There are two sets of triple-expansion condensing engines developing 2300 horse-power.

Meeting of the Mechanical Engineers

A Résumé of the Proceedings of the Semi-annual Meeting of the American Society, at Indianapolis, May 28 to 31, 1907

EDITORIAL CORRESPONDENCE

The semi-annual meeting of this society was held in Indianapolis May 28 to 31, the headquarters being at the Claypool Hotel, in the auditorium of which the sessions were also held. The proceedings began Tuesday evening, with the customary address of welcome by Mayor Bookwalter and an appropriate reply by President Hutton.

Wednesday Morning Session

The first session for the transaction of business was held Wednesday morning, the first action taken being the election of Andrew Carnegie as honorary member of the society. Following this the secretary announced the election of 254 members, associates and juniors during the year just passed, with a large number of applications now pending. The passage of the amendments to the constitution, one authorizing the council to appoint an honorary secretary, in its discretion, and the other authorizing the organization of a research committee, were then announced.

Following this a report of progress of the committee appointed to raise money for liquidating the debt of the society on account of the purchase of the land on which the Carnegie building stands was made by Fred J. Miller, chairman of the committee. Mr. Carnegie's donation comprises the building only, the societies being expected to purchase the land on which it stands. The share of the mechanical engineers is $180,000—the amount to be raised after applying the proceeds of the sale of the old building in Thirty-first street, being $120,000, of which the committee has already raised $70,000.

Following this came the report of the committee on standard proportions of machine screws, which has been reported several times before, but each time referred back to the committee because of dissenting opinions by various members. The discussion of the report was opened by the reading of a written discussion by G. A. Gulowson, who disapproved of the report as a whole, and suggested a new system in which the present system of machine screws should be discarded entirely, and be replaced by a series of sizes developed by extending the standard bolt system downward. The remaining discussion was entirely opposed to Mr. Gulowson's views, the universal opinion being that the work of the committee was now in satisfactory shape, and that it should be accepted. Mr. Carpenter, who stated that he represented the manufacturers of 80 per cent. of the output of taps and dies, made a strong plea for the acceptance of the report. Present conditions, he said, are intolerable and manufacturers have been putting off the starting of new standards of their own, because they expected a definite outcome of the committee's labors. The report of the committee was now satisfactory to the manufacturers, and if accepted by the society would be promptly adopted, whereas, should the report be rejected after all the labor that had been put on it, he felt that the movement would probably come to nothing. Finally, Mr. Neff, who, on behalf of the Brown & Sharpe Manufacturing Company, was the one to oppose the acceptance of the report the first time it was submitted, stated that the report was now in form to meet the approval of that company, and he moved its acceptance. His motion was carried.

Following this came the preliminary report of the committee on refrigerating machines—this report being a continuation of the work of the committee which rendered a report on a standard basis for refrigeration, which was accepted at the New York meeting of 1904. The present report gives directions for giving tests, and was submitted with a view of bringing out discussion as it was expected that many alterations would be necessary. Several such suggestions were suggested in the discussion at which Professor Jacobus, on behalf of the committee, expressed his gratification, especially as one of these suggestions applied to a point on which the committee had great doubt.

Following this came a paper on "The Collapsing Pressures of Lap Welded Steel Tubes," by Professor Stewart, this paper being supplementary to the one read by him at the Chattanooga meeting, and intended to cover the case of tubes which are out of round to an abnormal degree.

The next paper was on "The Balancing of Pumping Engines," by A. F. Nagle, and was an argument in favor of increasing the weight of plungers in vertical pumping engines in order to equalize the effort during the upward and downward strokes—the contention being that this would make feasible a large reduction in the weight of the fly-wheels commonly used. The paper was discussed by Mr. Reynolds, who disputed the author's claim, saying that the weight of fly-wheels now used arose from the necessity for providing that pumping engines should operate at very low speeds, and that this weight would not be materially reduced by the weighting of the plungers. Moreover, in some cases the plungers are of necessity too heavy, and in others they cannot be made sufficiently heavy for balancing as advocated in the paper. Professor Jacobus also disputed the author's claim that the weight of the wheel would be reduced to any large degree, his position being, however, from an entirely different viewpoint from that of Mr. Reynolds.

The concluding paper of the session was on "The Economy of the Long Kiln," by E. G. Soper, the object of the paper being to show the saving in fuel consumption as well as the increased capacity of the long over the short kiln when used for burning Portland cement with natural gas.

Wednesday Evening Session

The session of Wednesday evening was devoted to an automobile symposium, the papers being "Ball Bearings," by Henry Hess; "Air Cooling of Automobile Engines," by John Wilkinson; "Materials for Automobiles," by Elwood Haynes; "Special Auto Steel," by T. J. Fay, and "European Motor Railway Cars," by B. D. Gray.

The paper by Mr. Hess contains undoubtedly the most definite data regarding the design of ball bearings that have appeared in English, as well as a large collection of recommended lay-outs for typical cases, and a large number of working drawings of actual constructions of automobile ball-bearing crank and other shafts. The paper includes as an appendix a translation of Professor Stribeck's report of his investigations on the properties of balls and the proportions of ball bearings. So much of this paper as can be found room for will be republished in these pages, and it is hence unnecessary to say more about it here.

In the discussion Mr. Fay gave it as his opinion that the chief information wanted now regarding ball bearings relates to the materials to be used. He considered that the success of the bearings with which Mr. Hess's name is associated is due more to the high quality of the materials used than to the principles of their construction or to their design. He has now under way a series of investigations on this subject, of which he gave some particulars, including the chemical analyses of materials. Some of these analyses included the materials used by Mr. Hess, but referring to the balls, he said he had been unable to break or drill them. He regarded exact chemical composition as of a high degree of importance, saying that small differences in composition are accompanied by disproportionately large differences in properties.

(*Continued on page* 826.)

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Jumping at Conclusions—Some Things Not What They Seem

The man who arrives rather hastily at a conclusion regarding certain matters pertaining to machinery manufacture, like the individual who too readily forms opinions respecting some other subjects, is apt occasionally to be deceived in his suppositions, even though he may be exceedingly well acquainted with shop operations and procedure in general. It is quite natural for mechanics to judge of the quality of certain machines by the nature and requirements of the work on which they are to be used; for, as we are all well aware, when the most highly refined machine operations are to be performed, only the most accurate tools are to be depended upon, any attempt to manufacture parts commercially to close limits with apparatus not carefully constructed being impracticable, while for less precise requirements machinery of an altogether different quality may be entirely suitable.

Now if we consider for a moment some machines outside the tool line we may find some interesting exceptions to this general proposition; for there are not a few instances where machinery incorporating the highest grade of workmanship is utilized wholly for accomplishing what seems to the ordinary observer to be an unusually rough class of operations. Not only may the nature of the work on which this machinery is used be far from what would be termed precise, but also the treatment accorded such apparatus may be of the roughest, such in fact as might be expected at the hands of operators untrained in the art of dealing gently and skilfully with mechanical appliances.

For example, take the case of the rock drill, which, if one but uses his eyes as he travels about, will be seen to be subjected to about every indignity that a piece of machinery can be put to. Under continual shock and jar while in operation, and carelessly treated when out of use, its powers of endurance seem little short of marvelous. Unless one happens to take into consideration the fact that only a remarkably well built machine could stand up and work satisfactorily under such conditions, he will be inclined to jump at once to the conclusion that apparatus of this class must naturally be of rather a rough order, that any special degree of refinement in its manufacture would be useless and entirely wasted.

What, however, are the facts in the case? An acquaintance of ours who worked for some years for one of the most prominent firms manufacturing such drills was speaking some time ago about his first experience in their plant. He went there with the expectation of seeing much that was interesting in the way of interchangeable manufacture, and knowing some of the men in charge of departments and something of the general equipment, believed he would find many interesting methods in use. An especially high degree of accuracy in the work he did not look for. After spending several hours in viewing numerous performances which seemed little short of amazing, considering his preconceived notions of what rock-drill manufacture was like, he left with the firm impression that the rock drill as there constructed was "made like a watch." Later experience in the works as an employee, where he had ample opportunity for closely examining into details, revealed further refinements, and he learned that the limits of error allowed in many of the drill parts were quite as small and frequently finer than those permitted in the production of various accurate parts entering into machine-tool construction. He also learned that the very complete systems followed there for accurately making and gaging important members of a rock drill not only facilitated greatly the assembling of the machines in the works, but also enabled a man in a far-off quarter of the globe to obtain any individual piece required in the repair of a drill, with the assurance that it would go into place and work properly.

There is another interesting line of operations that may be touched upon in connection with the foregoing remarks relative to unusually high-grade work in certain mechanism where it is not looked for by the casual observer. Every machinist has in his home, on closet doors, bureau drawers and in other places, a dozen or more locks which very likely he never uses and which if he were to examine he would consider a pretty poor class of hardware. Unattractive in appearance and sold for a few cents apiece, there is little about these locks outwardly to suggest any special degree of accuracy in their component parts. Here is another opportunity for the uninitiated to deceive himself. Those acquainted with the processes in certain lock shops know that in the manufacture of the very cheapest of their products various pieces are held to quite close limits. In fact it has been said on good authority that the cheaper the grade of lock, the closer to the desired dimensions must certain parts be made in order that absolutely no time may be wasted in the assembling operations. It is obvious that where an article of this class is made to be sold at an extremely low figure no time can be spent in hand fitting of individual members; these must be produced as accurately as automatic machinery can make them. It is essential therefore that the system of gages utilized in the departments manufacturing certain of the parts entering into the make-up of such products should provide for the maintenance of close limits of accuracy, and the methods of inspection must also be of a character that will assure the weeding out of work not within the required limits.

New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A Large Gap Riveter with a Wide Range of Pressure

Modern boiler shops, whether for locomotive or stationary boilers, require riveters of large sizes and high pressures for much of their work, as well as the ability to vary these pressures at will.

The latest addition to this type of machine is the new riveter, made by the Bethlehem Steel Company, Bethlehem, Penn. Although this is known as their 17-foot 6-inch riveter, the gap is 17 feet 9 inches deep by 4 feet 6 inches wide, and the entire stake is in one steel casting weighing 96,240 pounds. From the center of the plunger to the bottom of the frame is 26 feet, showing the depth of the frame at the bottom. As the greatest thickness is 5 feet 5 inches, the rigidity of the frame can be accounted for.

The ram has a movement of 8 inches, which remains the same under all pressures.

The intensifier has five cylinders, three of these having plungers 2¾ inches in diameter, and the other two being 3¼ inches. With the line pressure of 1500 pounds per square inch there is a pressure of 25 tons on the rivet, and by making different combinations of the intensifier cylinders, the operator secures pressures of 50, 75, 100, 125 and 150 tons at will.

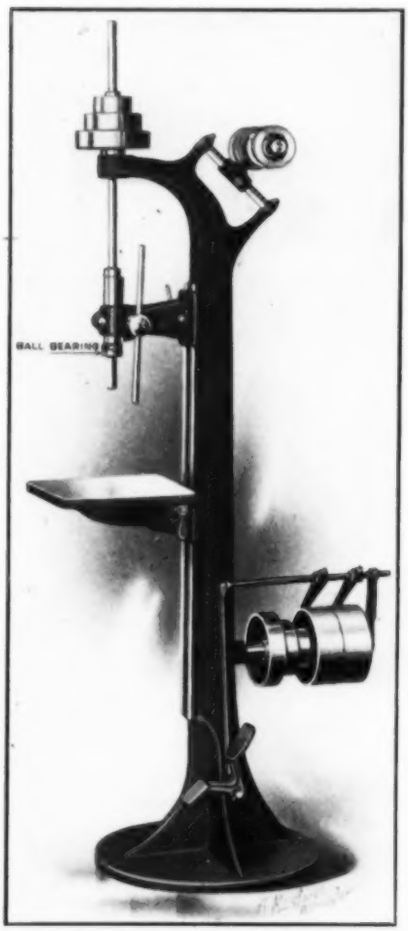
This does not mean either complication or confusion, as one setting valve gives any desired combination and the motion of the ram at any pressure is always under the control of a single lever.

The general arrangement of the valves, intensifier, operating platform, and other details, as well as the comparative size of the operator himself, can be seen in the illustration.

A LARGE RIVETER, 17 FEET 6 INCHES IN GAP

A Single-spindle Sensitive Drill

The novel feature of this new drill of the Francis Reed Company, Worcester, Mass., is the belt-shifting device in connection with the idler mounted on the short shaft near the top of the column.



SINGLE SPINDLE SENSITIVE DRILL

Sliding the idler along the shaft, to marked stops, shifts the belt to the different cones and preserves the right tension at all times. When adjusted it is held firmly in place by a tapered pin.

The machine is self-contained as the belt runs from the live shaft direct to the small countershaft shown at the back, the shifting of the belt being controlled by the foot-pad near the base.

The spindle pulley does not run on the spindle itself but on a babbitted stud in line with it, and taking all the strain from the spindle itself.

The spindle has a run of 5 inches by the usual steel rack and pinion and is always returned to the top by a flat coil spring, as soon as the lever is released. The spindle is ¾ inch in diameter, 35 inches long, has a No. 1 taper and is finished by grinding.

The head has a run of 14 inches and with table in lowest position will take in a piece 36 inches long. The table is 10 inches square and locks rigidly at any point. The total hight of drill is 72 inches, the base is 20 inches in diameter and the weight of drill is 250 pounds.

Relieving Attachment for the Lathe

The accompanying engravings illustrate a new relieving attachment for backing off the teeth of taps, cutters, mills, hobs, etc. As shown in Fig. 1, this attachment is bolted on the lathe-feed box and does not interfere with the use of the lathe for ordinary purposes. The construction of the attachment will be understood from Figs. 2, 3 and 4. The cam is driven from the lathe spindle by a series of change gears. A telescopic shaft connected to the attachment with universal joints carries a lever which has an adjustable roller and stud; this lever is actuated by the cam, and the stroke can be regulated to give a clearance of from 0 to ¼ inch.

The bronze nut in the compound-rest slide, Fig. 4, has a rack on its lower face and is actuated by a gear segment that is operated by the universal shaft. The compound rest has all the movements of a regular rest. It can be swiveled to any angle for backing off end mills and sides of square teeth, and the top slide can be adjusted with the screw at all times. The rest can be used in connection with the taper attachment. Two cams (Fig. 3) and a set of change gears are provided for giving from 1 to 24 movements per revolution of spindle. An index plate shows the cam and gears to use for any required number of teeth.

This attachment is made by the R. K. Le Blond Machine Tool Company, Cincinnati, Ohio, and can be applied to the 16-inch quick-change lathes made by that company.

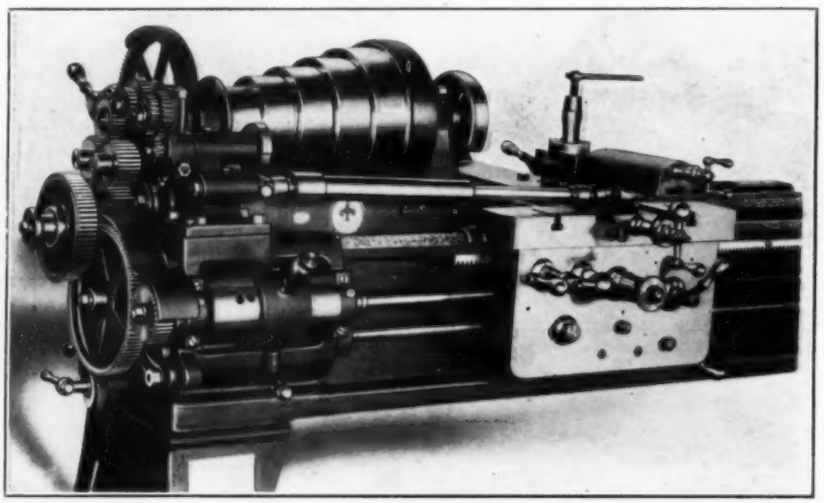


FIG. 1. RELIEVING ATTACHMENT FOR THE LATHE

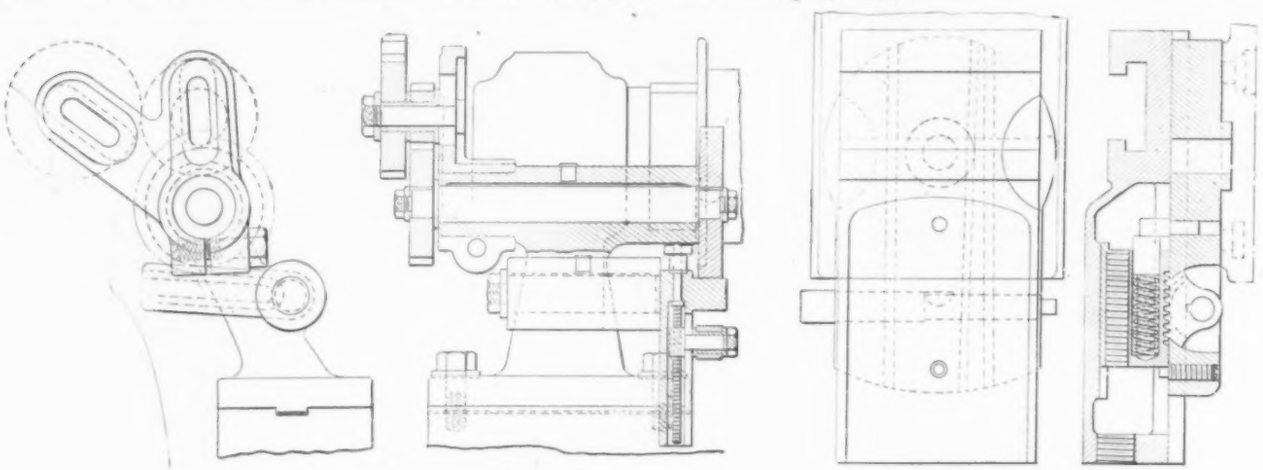


FIG. 2

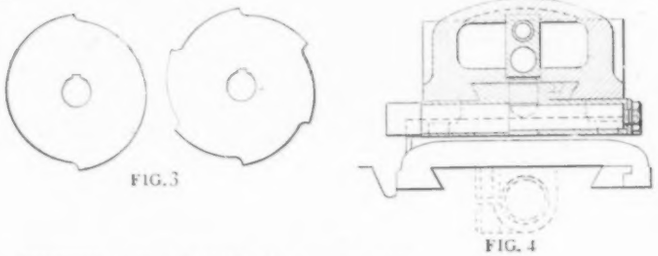


FIG. 3

FIG. 4

RELIEVING ATTACHMENT FOR THE LATHE

Milling Cutters with Teeth Cast into the Body

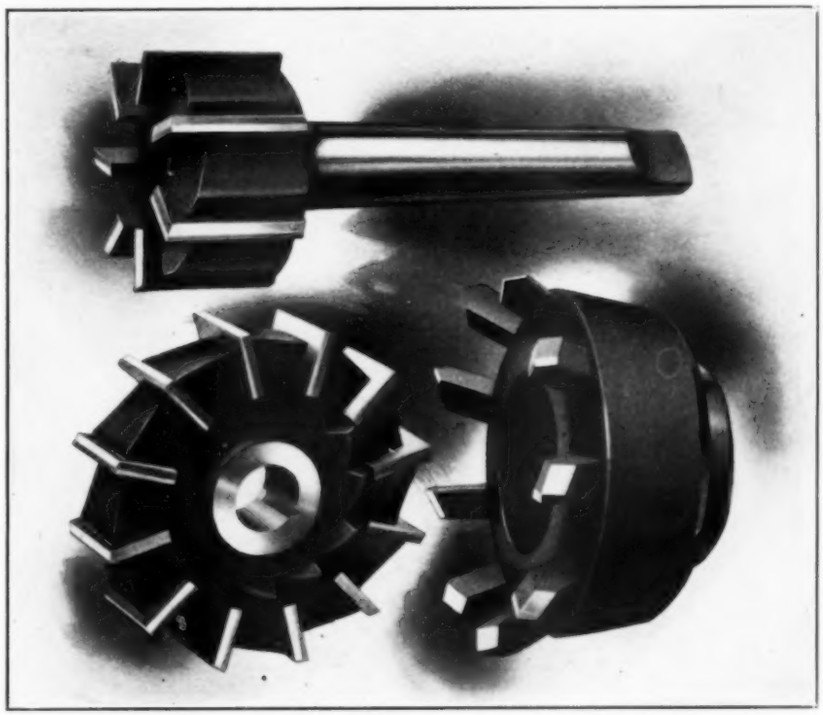
Users of milling machines know the advantages of having a good equipment of cutters of various sizes and shapes, as it materially increases the output of the machine to have just the cutter needed. They also know that this means a heavy investment, especially with high-speed steel.

To allow of a liberal milling-cutter equipment at a moderate cost the Harrison & Knight Manufacturing Company, of Newark, N. J., is making the three varieties of milling cutters shown in the engraving, with blades of high-speed steel as a part of a cast-iron body. The blades

are treated, before setting into the mold, in such a way that the cast iron adheres (or "freezes," in the language of the shop) to them, and the roughest kind of treatment in actual use has never loosened a blade.

The end or face mill shown above is made with a shank to any desired taper, both the Brown & Sharpe and Morse tapers being carried in stock. It is also made with threaded hole, if preferred. These range in size from 2 to 6 inches in diameter. Stock sizes of the side-milling cutters begin at 3 inches by 1-inch face and go up to 8 inches with 2⅛-inch face.

The face mill, with square steel cutters, is also made with either taper shank or threaded hole; regular sizes run from 3 to 6 inches. The shape of these teeth



THREE TYPES OF MILLING CUTTERS WITH TEETH CAST IN

enables them to be easily sharpened by hand if necessary, but a cutter grinder is always to be recommended.

The British Chamber of Commerce, at Paris, calls the attention of British shippers to the importance of accurately classifying their goods for the French customs, and the same caution would apply to American shippers. The customs authorities of France, it appears, do not rectify errors of this kind; they simply impose fines. Nor is it enough for the exporter to study the French tariff, since that "bristles with exceptions," and it is necessary also to pore over the explanatory notes of the customs administration and the decisions of the consultative committee, which are contained "in several large volumes."

Grinding Automobile Cylinders on a Boring Mill

BY J. N. HEALD

The experience of your correspondent, R. E. Marks, related on page 596, concerning the grinding of automobile cylinders on a boring mill, is both interesting and instructive. While he seems to think the results obtained made it impossible for him to tell a good story, he should have no regrets on that score for the story as related was excellent because it was so thoroughly true and so exactly what must be expected from that method of handling the work.

He says in regard to results obtained: "It wasn't round probably because there were soft spots in the iron; and it wasn't of uniform diameter because the wheel would wear enough to affect the diameter very materially in one passage through the cylinder."

I think his conclusions as to the reason for the hole not being round have been hastily reached.

WAS THE SPINDLE BEARING TRUE?

Before laying the errors to the character of the iron, or the wear of the wheel, we should wish to know whether the spindle beneath the table was perfectly cylindrical or not and whether it fitted its bearings closely.

Assuming, however, that these are O.K., of which there is not one chance in fifty within the limits used in measuring the hole, there is trouble enough indicated in the construction and mounting of the spindle to account for the errors found.

This spindle, as we read it, was made with babbitted bearings in place of the regular tool-holding head of the mill. Nothing is said in regard to the adjustments for bringing this bearing to the closest possible fit round the spindle and nothing is said in regard to using a hardened and ground spindle which it would be necessary to have in order to have the bearings stand up properly for any length of time.

WHEEL NOT SUPPORTED

I also understand that the spindle extended outside of the bearing far enough to reach into the cylinder the full depth. This construction, of course, gives no support to the grinding spindle close to the wheel and makes it very difficult to avoid serious vibration of the wheel during the grinding with the probability of chatter marks and errors in regard to accuracy of diameter.

I believe the difficulties of fitting up a spindle extending a considerable distance beyond the bearings, that will run at a high speed, say 5000 to 6000 turns per minute, without more or less vibration will be readily appreciated.

My experience has been that it is necessary to carry out a supporting sleeve, incasing the wheel spindle and furnishing a supporting bearing close to the wheel to give it the necessary stiffness to hold the wheel to the work and cut a true circle.

WHEEL MAY NOT BALANCE

Even then a 3- or 4-inch wheel will often be sufficiently out of balance, owing to uneven density or thickness or to a poor job of bushing, to make it run with vibration even when the spindle runs perfectly true with the wheel left off.

He also says that the hole was not of uniform diameter because the wheel would wear enough to affect the diameter in one passage through the cylinder. This indicates, if the trouble is really at this point, that the wheel is of too soft a grade for use with that particular speed. Possibly a harder wheel would work better, or what is more likely, a higher rotation of the wheel is needed to enable it to stand up to the work and give the results desired.

WEAR OF WHEELS

It has been my experience in the manufacture and operation of internal grinding machines that a grinding wheel of the right grade and grit will finish a hole say 4 or 5 inches diameter from rough boring, taking out 0.008 or 0.010 inch stock without wearing down more than 0.001 inch during the entire roughing and finishing cuts; and as the wheel passes through the cylinder a number of times, taking several heavy cuts to remove the stock and then lighter ones for the finish surface, the difference in diameter between one

end of the cylinder and the other is too small to be measured.

ROTATING WORK DOUBLES ERROR

A point to be considered in this connection which most likely was somewhat responsible for the size of the hole, is that when work is rotated in a machine of this kind, the difference in the diameters of the ends is always twice the actual error in alinement between the axis of the table and the line of motion of the sliding head. In other words, if there is an error of 0.001 or 0.002 inch between the direction of the axis of the table and the travel of the wheel head the cylinder will show 0.002 or 0.004 inch error in the same distance with absolutely no wear to the wheel.

You have only to remember some job of boring you did once in the old lathe (and not so old either) when you were going to make a fine driving or shrink fit, only to find on taking the work out of the chuck that it was a thirty-second of an inch more or less larger at the back end of the hole than you wanted it, to know how this way of grinding a cylinder is likely to work out.

BORING AND GRINDING DON'T COMBINE

The experience of R. E. Marks has been duplicated a great many times because many attempts have been made to combine both boring and grinding operations in one machine, and so far as we know, in every case this has proved a failure. First-class work is not possible with this arrangement because the heavier strains and racking developed in boring render it difficult to maintain the accurate adjustments necessary in a machine for grinding, and so far as the expense of handling the work goes, the time consumed in changing a cylinder from a boring machine to a grinding machine is of little importance when the superior results obtained are considered.

Mr. Marks also refers to the importance of allowing a certain time between operations, for the cylinder to change its shape due to relieving the strains in the iron in the machining process. By boring on one machine and grinding on another, making separate operations for these two processes, the cylinder may readily be given whatever time is convenient to allow it to season and reach the shape it tends to take.

BORING LEAVES IRON ROUGH

There is one other element that comes into this discussion, naturally, and that is in regard to the character of the surface obtained in a ground cylinder as compared with one that is bored or even bored and reamed. If the surface of the bored cylinder should be examined with a microscope, the surface would be found to be rough and ragged, showing where the particles of iron had been broken off by the cutting action of the boring tool.

When this cylinder is reamed, of course, this roughness is smoothed down to a certain extent, but still the surface of the iron is more or less rough and porous because the walls are so thin that they spring away under the action of the reamer and the finish obtained in reaming does not compare with that obtained in reaming holes in a solid block of iron.

SURFACE BY GRINDING

The surface, however, produced by grinding presents a different appearance under the microscope, as apparently the wheel cuts down to "hard pan," if that expression is allowable, and cuts away the rough porous surface, leaving a hard, solid, close-grained surface with more or less of a polish, the amount of the polish being dependent somewhat upon the grade of the wheel used and upon the speed of rotation at which the finishing cuts were made.

For automobile and gas-engine cylinders, it has been my experience that the surface made by a grinding wheel saves time and expense in boring, reaming and lapping and the cylinders hold their compression better, and the rings run in to a perfect fit with less wear both to rings and to cylinder walls, which means less opening at the cut where the ring is sprung together, resulting in less leakage and greater power when at work.

Planing Grooved Rolls in a Lathe

BY QUEBEC

I am going to tell you how my mate and I got out a difficult job at one time on one of my mate's ideas.

We were doing a job after working hours for a friend who owned a sawmill, making rollers to feed the planks into the planer. He was going to discard the wooden rollers and put in cast iron. They were made like the sketch. He had cast-iron rollers made and turned 3 inches outside and 1½ inches inside. Then there was a medium hard rubber bush and a ¾-inch shaft.

The smooth turned rollers would slip when he had a very heavy cut on, so he was nonplussed as to what to do. After a little thinking on our part, my mate got there first with the best idea. There was only a small foot-power lathe and a drill in the mill, but this is how we did it.

We took a gear from one of the planers and drove it on the end of the mandrel, then blocked it at every second tooth with a piece of iron against the shears. No driver was used, as the job was to stand still in the lathe while the lathe went round.

Then we made a tool with the cutting edge turned over to the side. With the high speed and a fast screw feed, the rest was easy. The feed pulled the carriage and tool, cutting the feed grooves readily.

Meeting of the Mechanical Engineers

(*Continued from page* 821.)

A correct general idea of Mr. Wilkinson's paper is given by its title. He divides the conditions into two sets which he defines as the external and the internal. Of these the most definite information exists regarding the internal conditions and the paper is largely a statement of this information. The paper brought out no discussion.

The paper by Mr. Haynes was to a large degree an account of the early difficulties of automobile makers, due to the inadequacy of the materials available—the beginning of the solution of these difficulties having been found in the use of nickel steel. He devoted a good deal of attention to vanadium steel of which the valuable peculiarities are that, combined with a high tensile strength, it has an elastic limit more nearly equal to the tensile strength than any other known material. He regarded the bronzes as of very limited value for automobile purposes, because of their low modulus of elasticity; but to this, exception was taken in the discussion.

The paper by Mr. Fay embraces the results of tests of materials now in use, gives the methods of determining the utility and hardness of the various materials, discusses the range of use of steel and points out the difficulty in machining the new alloy steels because of their hardness.

In the discussion Mr. Hess enlarged upon the difficulties of machining the alloy steels, saying that until recently he had been unable to make his ball bearings as cheaply as they could be imported with the duty added to the original cost. He had attempted to produce these bearings by American methods using automatic and semi-automatic machines for the purpose, but this attempt had proven a failure, largely because of the rapid destruction of the cutting tools. He had been compelled to abandon these methods and to resort to those used in the German factory where the work is done on the simplest and most elementary machines using the simplest possible tools.

Because of the lateness of the hour Mr. Gray's paper was postponed until the Thursday morning session.

THURSDAY MORNING SESSION

The first paper taken up at this session was on "European Railway Motor Cars," by B. D. Gray. The paper called attention to the considerable and increasing use of railway motor cars as feeders in Europe, and gives a good deal of information about these cars which are both steam- and gasolene-engine driven. The discussion was opened by Mr. Blood who did not believe in the combination of the motor and car, largely because of the absence of

facilities for repairing both elements in the same shop. He also considered the gasolene motor unsuitable for the purpose. It is one thing to use gasolene occasionally in a motor car and quite another to use it in regular service, for which its cost is prohibitive. He considered the best solution for this class of traffic to be a separate specially designed steam locomotive fired with fuel oil. His opinions were generally concurred in by Mr. Forsythe, President Hutton, and Professor Goss.

In the program, the session for this morning was laid out to be a special session devoted to superheated steam, on which topic the following papers were offered:

"The Specific Heat of Superheated Steam," by A. R. Dodge; the Flow of Superheated Steam in Pipes," by E. H. Foster, and "The Determination of Entropy Lines for Superheated Steam," by A. M. Greene.

Mr. Dodge's paper is the result of very extensive experiments undertaken at large cost by the General Electric Company, which have run through several years. The general conclusion of the author is that the specific heat of superheated steam increases with increasing pressure with no variation due to variations in temperature at constant pressure. Mr. Foster's paper is the result of observations on existing plants and not of experiments, but while he regards systematic tests as necessary, he considers himself justified in drawing certain general conclusions. The paper by Mr. Greene explains the method of using the curves for the determination of the total heat required to superheat a pound of dry steam, and follows this by a simple graphic method of computing the entropy change from one temperature to another—the results being plotted on a diagram.

The discussion was opened by Professor Reeve, who devoted his attention especially to Mr. Dodge's paper, which he considered of very large value, but nevertheless containing points which need to be cleared up, and which he proceeded to specify. Professor Carpenter pointed out that other experimenters had generally obtained higher values for the value of the specific heat of superheated steam, and Mr. Dirks submitted a sheet of curves, which he had obtained from German experiments. Mr. Toltz, discussing Mr. Foster's paper, pointed out the increased loss of heat, due to a reduced velocity of steam in the pipe—a large heat loss being accompanied by a low friction loss and *vice versa*. Professor Wagner, in discussing Mr. Dodge's paper, pointed out that the observations were erratic, and he did not consider the conclusions justified by the observations. Professor Jacobus agreed with Professor Wagner, and proceeded further to criticize the apparatus employed, saying that he had undertaken similar experiments with similar apparatus, which he had found untrustworthy, and hence had not published the results.

Following this came a paper on "Superheat and Furnace Relations," by R. P. Bolton, and one on "Materials for the Control of Superheated Steam," by M. W. Kellogg.

Mr. Bolton's paper called attention to the desirability of so relating the furnace and superheater construction and the conditions as to produce superheated steam of defined character, and to the desirability of a more comprehensive study of the combination of grate, arch, walls, combustion space and draft. Mr. Kellogg's paper discussed the subject of materials for pipe, fittings, valves, joints, gaskets, etc.

In the discussion Mr. Foster considered very little change in pipe lines necessary to adapt them to the use of superheated steam, and instanced cases in which pipe lines, designed for saturated steam, had been used successfully for superheated steam. He did not share the prevailing objections to the use of cast iron for superheated steam. Mr. Kruesi considered 125 degrees of superheat to be all that should be used in the present knowledge of the subject, and this only for the largest plants—the amount of superheating being progressively reduced for small plants. He strongly objected to the use of cast iron, and referred to cases where tons of fittings made of this material had been discarded after trial. He regarded gate valves as entirely unsuited to superheated steam, for which he would use nothing but globe valves. Mr. Brown pointed out that while the use of superheated steam led to a considerable gain in steam economy, it led to a much less gain, and in some cases to an actual loss, in coal economy.

The final paper of the session was on "The Cost of Heating Storehouses," by H. O. LaCount.

The paper points out the greater security due to the use of the wet-pipe system of automatic sprinklers—a security which is partly sacrificed in unheated storehouses, because of the necessity for using the dry-pipe system. He has made exhaustive inquiry into the cost of heating storehouses, and finds that while, compared with the cost of a dry-pipe equipment, it would be slightly more, nevertheless the difference is, in general, negligible.

Friday Morning Session

The session of Friday morning was held at Purdue University, the members being taken from Indianapolis to Lafayette in a special train. The papers presented were on "The Performance of Cole Superheaters," by W. M. F. Goss; "Experiences with Superheated Steam," by G. H. Barrus; "Superheated Steam in an Injector," by S. L. Kneass; "Use of Superheated Steam on Locomotives in America," by H. H. Vaughan; and "Analysis of Locomotive Tests," by S. A. Reeve.

The paper by Professor Goss gives the performance of the experimental locomotive at Purdue University after the application of a superheater. The paper by Mr. Barrus refers to the use of an engine at the Massachusetts Institute of Technology and gives the results of tests showing the quantity of coal required for a given amount of superheating, or the saving in coal or in steam produced by the superheater. The paper by Mr. Kneass describes the action of superheated steam in an injector, which reduces the efficiency and may prevent the operation of an improperly designed injector.

The paper by Mr. Vaughan comes from Canada and discusses some of the troubles experienced with superheaters and the methods taken to overcome them on the Canadian Pacific Railway, which has made much greater use of the superheater than all of the railroads in the United States combined. The Canadian Pacific has, including those now on order, 372 engines equipped with superheaters, while there are but 15 such engines in the United States. The author concludes that the use of superheaters on locomotives is, on the whole, satisfactory, and that an increase in their number may be expected.

The paper by Professor Reeve is based on the results of the locomotive tests made at the St. Louis Exposition, and points out some losses the source of which is so far unexplained.

In discussing these papers Mr. Kruesi stated that in the experience of the General Electric Company the saving of steam due to superheating averaged about 1 per cent. for each 12 degrees of superheat, a moderate amount of superheat giving a larger relative saving than a larger amount. Information regarding the consumption of coal for superheating is not very exact, and hence the actual plant economy is somewhat uncertain. Mr. Foster disagreed with Mr. Kruesi's statement of Thursday that superheating is advisable for small plants. He had obtained remarkable results in plants of moderate capacity, that saving being seldom less than 10 per cent., and occasionally as high as 20 and 25 per cent, these figures being more than can be accounted for by theory. Mr. Toltz detailed the experience of the Great Northern Railroad, with superheaters, which showed a saving of from 15 to 18 per cent. of coal for passenger, and from 12 to 15 per cent. for freight traffic. In Europe savings from 25 to 30 per cent. are reported. He insists that engines must be designed for superheated steam if successful results are to be expected.

In connection with the meeting there were the usual excursions to manufacturing plants, and also to Purdue University, where the engineering laboratories were inspected with much interest. A unique feature of the meeting grew out of the dedication of the monument to General Lawton on Thursday, on which occasion

President Roosevelt was present. The members of the society were presented with tickets admitting them to the guests' platform.

Obituary

Francis Ludlow Clark, chief engineer of the Westinghouse Air Brake Company, died at Los Angeles, May 27, in his sixty-fifth year. Mr. Clark had for the past 40 years been connected with the Westinghouse interests and rose from the bottom to the important position he held at the time of his death.

Albert P. Sibley, president, treasurer and general manager of the Sibley Machine Tool Company, died at South Bend, Ind., aged 60 years. Mr. Sibley started his career in the machine-tool business as an apprentice in the L. W. Pond shops, at Worcester, Mass., 40 years ago. In 1873, just at the time of the panic, Mr. Sibley, with J. R. Mills, a shopmate, decided to establish a business, and purchased material from L. W. Pond, to make the machinery which they later brought to South Bend, Ind., to start their shop. They returned East shortly, and induced George O. Ware, a former shopmate, to enter their establishment at South Bend.

Business Items

The office address of the Standard Roller Bearing Company, Philadelphia, has been changed to corner Fiftieth street and Lancaster avenue.

A recent addition to the equipment of Phillips & Buttorff Manufacturing Company, Nashville, Tenn., foundry department, is a 16-ton-per-hour cupola, manufactured by the Northern Engineering Works, Detroit, Mich.

The shop, together with all machinery and patterns of the Fulton Machine and Vise Company, Lowville, N. Y., was destroyed by fire on May 19. They request that manufacturers send catalogs to replace those destroyed.

Owing to the continued increase in the number of orders for its automatic gear cutting machines, Eberhardt Bros. Machine Company, Newark, N. J., has discontinued the manufacture of crank shapers. The Machine Sales Company has arranged to take over the production of the shapers and will manufacture them at its plant at Peabody, Mass.

At the recent annual meeting of the directors and stockholders of the Ridgway Dynamo & Engine Company, of Ridgway, Penn., the sales department was reorganized. H. A. Otterson, formerly assistant superintendent, was made sales manager, with R. C. Eccleston as assistant. In addition to the usual work, the control of all agencies, and the advertising has been placed in this department.

Allis-Chalmers Company, Milwaukee, Wis., has received from the U. S. Steel Corporation an order for 32 gas-engine-driven electric generators, aggregating 68,000 kw. Sixteen of these are for the new plant at Gary, Ind., now in course of construction, and the other sixteen units are for the Homestead plant of the Carnegie Steel Company, the South Chicago and Bay View (Milwaukee) works of the Illinois Steel Company, and for the central furnaces of the American Steel and Wire Company, Cleveland, O.

Trade Catalogs

Pratt & Whitney Co., Hartford, Conn. 1907 catalog of small tools. Illustrated, 4½x7 inches, 216 pages, paper.

Billings & Spencer Co., Hartford, Conn. Pamphlet containing price list of machinists', riveting and tack hammers. Illustrated.

Ideal Opening Die Co., 24-27 West St., New York. Catalog describing screw cutting dies. Illustrated, 3½x6 inches, 16 pages, paper.

Scully Steel & Iron Co., Chicago, Ill. Catalog of Scully rotary spitting shears. Illustrated, 6x9 inches, 16 pages, paper. Catalog of Wangler rotary beveling shears. Illustrated, 6x9 inches, 12 pages, paper.

Manufacturers

The Cyclone Fence Company, Waukegan, Ill., will build an addition.

The National Lead Company, Chicago, Ill., will enlarge its plant.

The Bryant Electric Company, Bridgeport, Conn., is erecting an addition.

The Woronoco (Mass.) Paper Company erect a new four-story addition.

The Emerson Steam Pump Company, Alexandria, W. Va., will enlarge its plant.

The Brinser Handle Company, Manchester, Va., is building an addition to its paint.

The Parker Pen Company, Janesville, Wis., will build a new $100,000 model factory.

The Self-Threading Needle Company, Minneapolis, Minn., is erecting a new four-story plant.

The Union Roofing and Manufacturing Company, St. Paul, Minn., will erect a new factory.

The Pioneer Pole and Shaft Company, Memphis, Tenn., will erect a plant in Gilbert, La.

The Hocking Valley Railroad has let the contract for new shops at Logan, O., to cost $90,000.

An extensive machine shop is to be erected at the plant of the Sylvan Steel Works, at Moline, Ill.

The New York Central Railroad has appropriated $150,000 for a new roundhouse at Oswego, N. Y.

The Dayton Folding Box Company, Allegan, Mich., will make improvements to cost about $10,000.

Joseph T. Ryerson & Son, Chicago, Ill., wholesale iron and steel, will build a new factory and office building.

The American Shipbuilding Company will enlarge its plant at Bay City, Mich., and abandon the Chicago plant.

The E. L. Yancey Carriage Company, Culpepper, Va., will rebuild its plant, recently burned at a loss of $10,000.

Allen Manufacturing Company, Nashville, Tenn., will build a two-story addition to its stove manufacturing plant.

The South Bend (Ind.) Iron Bed Company will move to Mishawaka, where a new plant costing $12,000 will be erected.

The American Car and Foundry Company, Chicago, Ill., will enlarge its plant by the addition of a new foundry, to cost $25,000.

The W. S. Tyler Company, Cleveland, O., manufacturers of ornamental metal specialties, will erect a new factory building

The Bremen (Ga.) Machine Company will make additions and install new machinery, which will consist of lathes, drills, etc.

The Alma (Mich.) Manufacturing Company, building gasolene engines, has decided to erect a $200,000 addition to its plant.

The Arkansas Central Railroad will build roundhouse and machine shops at Paris, Ark. J. H. Wright, Fort Smith, Ark., is president and treasurer.

The Troy (N. Y.) Waste Manufacturing Company has taken out a permit for a new five-story building to replace the one burned some time ago.

The Carter Motor Car Company, Washington, D. C., is having plans prepared for a two-story factory building at its new location at Berwyn, Md.

Fire at the plant of the Shelby (Ala.) Iron Company damaged the coke-iron furnace to an extent of $20,000. It will be rebuilt along more improved lines.

The Pittsburg (Penn.) Screw and Bolt Company has had plans prepared for a four-story factory building to replace the one destroyed by fire recently.

The Lyman Mills Corporation will build a five-story brick mill in addition to the present cotton manufacturing plant in Holyoke, Mass. This will cost $150,000.

The Citizens' Ice and Manufacturing Company, Houma, La., recently incorporated, will erect and equip buildings at a cost of about $10,000. H. L. Wilson is general manager.

The Standard Safety Boiler Company, Fort Wayne, Ind., has been incorporated with a capital of $50,000. Samuel K. Gregg, Chas. E. Colerick and Walter M. Gregg are directors.

The Advance Foundry Company, Dayton, Ohio, has taken out papers of incorporation and will rebuild the plant recently destroyed by fire. It will be equipped with the latest machinery.

The General Paper Stock Company, Wellston, Mo., has been incorporated to manufacture paper. Capital, $250,000. Incorporators, George D. Allen, George M. Brown and F. A. Peters.

The Louisville & Nashville Railroad will construct machine shops, freight yard, etc., at New Oorleans, La., improvements to cost $150,000. W. H. Courtenay, Louisville, Ky., is chief engineer.

The foundry, pattern shop and core room of the Prime Steel Company, of Milwaukee, Wis., at Lake, Wis., were destroyed by fire, causing a loss of over $20,000. The plant will be rebuilt.

The Longacre Electric Light and Power Company which is controlled by the Manhattan Transit Company, of New York, has purchased site on which a 100,000 horsepower plant will be erected.

The Pittsburg-Buffalo Company, of Pittsburg, Penn., is said to be planning the erection of ovens, repair shops, foundries, etc., at Marianna, a new town to be established by the company near Zollarsville, Penn.

Ward's Engineering Works has been incorporated at Charleston, W. Va., to manufacture water-tube boilers, machinery, engines, etc. Capital, $250,000. Incorporators, Harrison B. Smith, R. S. Spillman, etc.

The Orcutt Manufacturing Company has been formed at Omaha, Neb., to deal in scales, machinery, and iron and steel products in general. W. E. Orcutt, Darius M. Orcutt and J. M. Pendleton, incorporators.

The National Milking Machine Company is being incorporated at Waterloo, Iowa, with a capital of $1,000,000 to manufacture a milking device patented by E E. Gord, of Waterloo, who is one of the incorporators.

The Stewart Vehicle Company, Martinsburg, W. Va., has been incorporated with $[illegible],000 capital. A plant for the manufacture of buggies will be erected. Claude Stewart,

N. W. Downey and H. H. Emmert, incorporators.

The Standard Chain Company, Pittsburg, Penn., has decided to build a plant at Walkersville, Ont., and the Standard Chain Company, of Canada, Ltd., has been formed to operate the new works which will cost about $200,000.

Plans have been prepared for a large foundry for the Stanley Electric Manufacturing Company, Pittsfield, Mass. This will cost about $300,000 and a large sum will also be spent on cranes, pattern-making and casting machinery.

Fire at the plant of the Holbrook-Armstrong Iron Company, Racine Junction, Wis., destroyed the machine shop, molding shop, pattern room, wood department and engine room. Loss about $20,000. The burned buildings will be rebuilt.

Fred W. Swain, formerly of the Powell Automobile Company, Omaha, Neb., is promoter of a factory to manufacture a gasolene engine, of which he is the patentee. The building will be erected at South Twelfth street and the Boulevard, Omaha, and cost $12,000.

The Humboldt-Portland Cement Company has been incorporated with a capital of $2,000,000. A large plant will be erected at Humboldt, Kan., which will be equipped with the latest and most approved machinery for manufacturing high-grade portland cement. C. H. Pattison, of the Union Gas & Traction Company, of Kansas City, Mo., is president.

The Glens Falls (N. Y.) Machine Works has been formed to take over the business of the Moore Screen Company, of Sandy Hill, N.Y., and Tromblee & Paull, of Carthage, N. Y. A plant is being erected at Glens Falls for the purpose of manufacturing the Moore screen, the Tromblee & Paull rotary sulphur burner, centrifugal turbine pumps and other paper and pulp mill machinery. The tools and equipment will be of the latest designs and will be driven by electricity with individual motors.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282. AMER. MACH.

Will buy or pay royalty for good patented machine or tool. Box 52. AMER. MACHINIST.

We desire a few more machines or specialties to manufacture. Address Box 423, Troy, N. Y.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Contract machine work, tools and dies to order. Northwestern Machine Co., Detroit, Michigan.

Special machinery built to order; let us estimate on your work. Capital Foundry and Machine Company, Frankfort, Ky.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Special machinery to order. Catalog of small engines and boilers and engine castings 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

Learn how to etch your name on your tools; extremely simple; invest a quarter and prevent loss of tools. C. R. Beeman, 420 University Bldg., Syracuse, N. Y.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Wanted—Suitable machine shop facilities for building high speed vertical compound steam engines in sizes from 40 to 450 horsepower. Address Box 36, AMER. MACHINIST.

If Henry Weller, formerly of Batavia, Rochester and New York, will send his address to John Henry Blake, care Thomas Cook & Son, Paris, France, he will learn something to his advantage.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers. 146 West 56th street.

Advice: mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

Wanted Company with good machine specialty who desire to increase output by investing small amount of capital to reorganize a plant at present in operation under a receiver; investment need not be large and a good chance for the proper parties. Box 38, AMERICAN MACHINIST.

Proposals for furnishing twelve turret gun sights will be received at the Bureau of Ordnance, Navy Department, Washington, D. C., until 12 o'clock noon, June 15, 1907, when they will be publicly opened; forms of proposals and all information may be obtained from the Chief of Bureau of Ordnance, Navy Department. N. E. Mason, Chief of Bureau of Ordnance, May 25, 1907.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Position wanted; am 37 years old, have been employed in the office of one firm, who manufacture small tools and light machinery for 21 years and have a practical business knowledge acquired by such a training. Ernest L. Whiten, 23 Perry St., New London, Conn. 'Phone 643-5.

A general all-around mechanic, designer, and mechanical engineer, at present holding position of general superintendent desires to change; am well informed of modern tools and equipment of interchangeable manufacturing; electrical as well as mechanical; over twenty years experience; best of references. Address "Superintendent," 136 Myrtle Ave., Stamford, Conn.

MASSACHUSETTS

Situation as foreman of automatic or hand turret department; 12 years' experience, up-to-date on speeds and feeds and best methods of production. Box 34, AMER. MACHINIST.

Toolroom foreman, acting as assistant superintendent of shop employing 200 men, manufacturing small accurate tools, desires change. Age 28; inventive and resourceful; references. Box 47, AMERICAN MACHINIST.

Mechanical superintendent, now employed, experienced in interchangeable manufacture; successful shop organizer and manager of men; systematic and practical; age 36. Address Box 46, AMERICAN MACHINIST.

Foreman machine pattern maker; thoroughly conversant with intricate work on Pridmore and other machines; designing, drawing and executing, also experienced on hand, vibrator, plate and other forms of metal pattern work; executive ability. Address Box 12, AMERICAN MACHINIST.

Wanted—Position as machine tool and machinery salesman by a practical shop man, expert machinist and toolmaker; 32 years of age, considerable traveling experience; business getting salesmanship guaranteed; east of Buffalo; A-1 references as to ability, integrity, honesty, etc. Address "J. I. J. P.," care AMERICAN MACHINIST.

NEW JERSEY

Master mechanic or foreman open for engagement; excellent tool maker and designer of labor-saving devices; strong executive and good manager of help; A-1 references. Box 977, AMERICAN MACHINIST.

Wanted—Position as factory manager or superintendent by one thoroughly familiar with the design and manufacture of gas, gasolene and producer gas engines and producers; capable of producing the best results. Address "Reliable," AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 14, AMERICAN MACHINIST.

Position as designer by a toolmaker, jigs, gages; diemaking experimental; $24 per week; 25 years' experience Box 51, AM. M.

Valve specialist; eleven years' shop and office experience; present designer in charge, desires change. Box 28, AMER. MACHINIST.

Draftsman, mechanical, first class, wants position; 10 years of practical experience in automatic machinery and tools. Box 44, AMERICAN MACHINIST.

General foreman at liberty, light or medium work, tools designed for rapid production; work systematically handled. Box 53, AMERICAN MACHINIST

Experienced mechanic desires position as foreman of machine shop or tool room; excellent references as foreman; satisfactory reasons given for change. Box 45, AM. M.

Superintendent solicits correspondence from parties wanting an up-to-date live man; good mechanic and executive; replies treated confidentially. Box 49, AMERICAN MACHINIST.

Gas and oil engine expert, at present erection engineer for a large concern earning $100 a month; 10 years' technical and practical experience to all kinds of gas producers and gas engine plants; wish position as designer or foreman in gas engine factory. Address Box 19, AMERICAN MACHINIST.

PENNSYLVANIA

Machine shop foreman desires change; good reference. Box 4, AMERICAN MACHINIST.

Experienced designer of larger gas, steam, plunger pump engines, German University graduate, with executive ability. Box 54, AMERICAN MACHINIST.

Mechanic and draftsman used to experimental and development work; fair knowledge of chemistry; can work up new processes, handle help, had charge machinists on such work; experienced in electric furnace construction and operation; salary $24 week; age 39. Geo. Wyatt, Keystone House, Lancaster, Pa.

WISCONSIN

Expert mechanic with shop and drawing-room experience desires to represent some good concern and travel out of New York City. Box 48, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

A competent traveler in heating and ventilating wanted; give references. Dominion Heating and Ventilating Co., Hespeler, Ont.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

ILLINOIS

Wanted—Diesinkers familiar with very small accurate die work and punch-press swaging; only first-class men will be considered; modern factory, located in a desirable residence city; state reference, present position and wages wanted. Box 42, AM. MACH.

INDIANA

Wanted—Foreman for assembling department of factory manufacturing gasolene engines. Box 16, AMERICAN MACHINIST.

Wanted—Fifteen lathe men and assemblers; new shop, good wages, steady employment. The Western Motor Company, Logansport, Ind.

MASSACHUSETTS

Wanted—One experienced screw machine hand, one general gear cutting man; skilled inspector for machine parts; good working foreman on turret machines. Boston Gear Works, Norfolk Downs, Mass.

Wanted — First-class toolmaker, experienced on punching and forming dies, models, etc.; good opening for right man, in small but growing concern making vending machines and novelties. The Holbrook Mfg. Co., Attleboro, Mass.

Wanted—Foreman for repair shop and millwright's gang; must be an experienced mechanic and accustomed to handling men on quick repair jobs; old established manufacturing plant in suburb of Boston; open shop; no labor troubles. Box 39, AMER. MACH.

Wanted—Foreman to take full charge of tool supply and tool issue rooms in an old established manufacturing plant in suburb of Boston employing 1200 men; open shop; no

labor troubles; must have had long experience in systematic tool room work. Box 40, AMERICAN MACHINIST.

Mechanical superintendent for a gear cutting machine shop doing contract work on small and large orders, employing about 75 to 100 men; must be thoroughly capable mechanic; must have originality, and several years' experience in handling men; all applications in writing, stating age, giving references as to ability and character; all communications confidential. Boston Gear Works, Norfolk Downs, Mass.

Superintendent, by growing company building high-grade grinding machinery and employing about 100 hands; must be thoroughly up-to-date in methods, successful in handling men, and able to produce first-class work at reasonable cost; other things equal, preference will be given man with experience on first-class machine tools; write fully as to experience, age, salary expected and present position; confidential if desired. Box 2, AMERICAN MACHINIST.

Wanted—A young man to assist superintendent as shop foreman in a shop employing 150 men manufacturing small tools; must be familiar with manufacturing small tools and capable of handling men and getting out work; we have a desirable position for a competent man; references must be of the best; in answering give age, experience and about what salary would be expected; factory in Massachusetts; answers to this ad will be held strictly confidential. Box 990, AMERICAN MACHINIST.

MICHIGAN

We have a first-class position open for a mechanical draftsman and engineer who is familiar with duplex pump designing and shop practice. Box 991, AMER. MACHINIST.

MISSOURI

Wanted — Six first-class erecting machinists; also 3 gas engine erecting engineers; state references, experience, and salary expected. Box 35, AMERICAN MACHINIST.

Draftsman wanted — Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Tool die and instrument makers accustomed to accurate complicated work; steady work and good wages to thoroughly competent men; give references. Address Box 438, AMERICAN MACHINIST.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Fond Machine Tool Co., Plainfield, N. J.

NEW YORK

Wanted—Competent machine shop foreman familiar with automobile construction; state age, experience and expectations. Address "Permanent," AMERICAN MACHINIST.

Patternmakers Wanted—Several first-class pattern makers in machine shop; vicinity Albany, N. Y.; to first-class men good wages and a permanent position guaranteed. Address Box 18, AMERICAN MACHINIST.

Wrenches; practical designer and manager wanted for successful western factory; willing to invest small amount as earnest of good faith; experienced man only; confidential. Box 33, AMERICAN MACHINIST.

Wanted—Assistant machine shop foreman familiar with latest methods of production, valves and fittings; must have good executive ability to get out work quickly; permanent position for right man. Box 56, AM. MACH.

Wanted—By large manufacturing concern, experienced tool designer; no attention will be paid to answers to this advertisement unless accompanied by statement of experience and name of present employer. Address Box 41, AMERICAN MACHINIST.

Wanted—By an old established concern, foreman familiar entirely with making of steel castings, suitable for high pressure steam; state age, married or single, if now employed and experience in detail. Box 55, AMERICAN MACHINIST.

Non-union toolmakers accustomed to small accurate work; 42 cents per hour, 54 hours per week; non-union screw machine hands, accustomed to Brown & Sharpe hand and automatic machines, 35c. per hour, 54 hours per week; machinists accustomed to lathe, drill press and bench work, 30c. per hour, 54 hours per week; steady employment guaranteed to first-class men. Apply Jones Speedometer Factory, New Rochelle, New York.

OHIO

Wanted—In middle west, first-class machinists on floor and vise machines; no labor troubles; steady employment at good wages. Box 1, AMERICAN MACHINIST.

Wanted—First-class die and toolmakers on bench and vise work on forming, embossing and cutting dies; steady employment, first-class wages; excellent conditions; no labor troubles. Box 37, AMERICAN MACHINIST.

Forge foreman for general forge plant, consisting of steam drop hammers, Bradley hammers, welders, polishers, grinders and assemblers. Apply, with references, also stating experience and salary expected. Box 43, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted — Lathe, planer and boring mill hands. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—A man to act as instructor in machine design and mechanical drawing; must be a college graduate with at least three years' practical experience at the board; preferably in the designing of hoisting machinery or machine tools. Box 11, AMER. MACH.

Wanted—An energetic superintendent for a plant having pattern shop, foundry and machine shop, employing 100 men, and building machine tools and other specialties; a good opportunity to get into a growing business; must be capable of handing men, and getting out good work at reasonable cost; position permanent for a first-class man. Box 50, AMERICAN MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

WISCONSIN

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reasons for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

For Sale

Test Indicators. H. A. Lowe, Cleveland, O.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—The leading jobbing pattern shop of Colorado. Address J. L. Gard, Denver.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, Ohio.

One Garvin, two spindles No. 2 profiling machine, never been used, cheap if sold at once; for further information inquire of the International Co., Columbus, Ohio.

For Sale—One 72" Wais & Roos power squaring shear; in splendid condition; used but little; first check for $250 takes this machine. Box 23, AMERICAN MACHINIST.

For Sale—Ten volume library covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

For Sale—60 h.p. Bigelow return tube boiler; A-1 condition; 80 lb. pressure allowed by Hartford Steam Boiler Insurance Company; just removed to install larger one. West Haven Mfg. Co., New Haven, Conn.

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Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cochrane-Bly Co., Rochester, N. Y.

Arbors—*Continued.*

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arches, Boiler Door

McLeod & Henry Co., Troy, N. Y.

Architects

Ballinger & Perrot, Phila., Pa.
Dodge & Day, Philadelphia, Pa.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, Ohio.
Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.

Barrels Steel—*Continued.*

Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Baird Machine Co., Oakville, Ct.
Globe Machine & Stamping Co., Cleveland, Ohio.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller
Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing
Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Filler
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine
Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belting, Leather
Main Belting Co., Phila., Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work
Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bertsch & Co., Cambridge City, Ind.
Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Swaine Mfg. Co., Fred J., St. Louis, Mo.

Bending Tools, Hand
Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw
Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chain
See Hoists, Hand

Blowers
American Blower Co., Detroit, Mich.
American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
Garden City Fan Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines
General Electric Co., Ntw York.
Soltmann, E. G., New York.

Blue Print Paper
Soltmann, E. G., New York.

Boilers
Struthers-Wells Co., Warren, Pa.

Boiler Setting
McLeod & Henry Co., Troy, N. Y.

Bolt and Nut Machinery
Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads
Lang Co., G. R., Meadville, Pa.

Bolts, Coupling
Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, Ohio.

Bone for Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Technical
American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Philadelphia, Pa.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del
Binsse Mach. Co., Newark, N. J
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.

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Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote
Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction
Electric Controller & Supply Co., Cleveland, O.

Brazing
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Brazing and Tempering Powders
Phillips, Lafitte Co., Phila., Pa.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson Mass.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Smith Co., Ernst G., Columbia, Pa.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels

Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.

Castings, Iron—*Continued.*
Manufacturers Foundry Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.
Krupp (Thos. Prosser & Son), New York.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
National Machine Co., The, Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

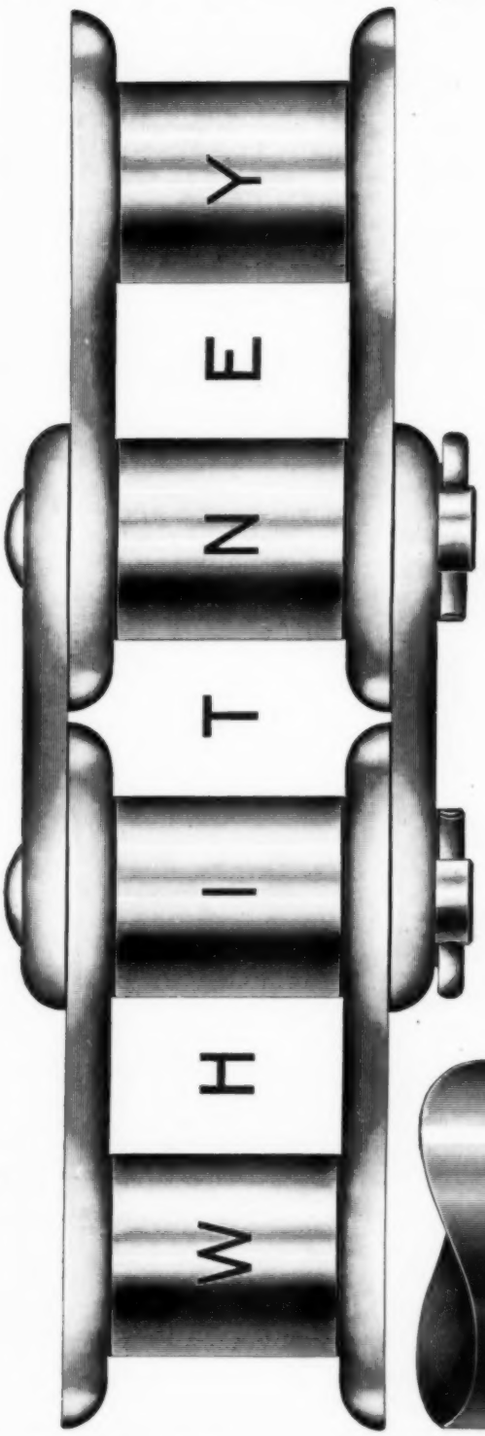
Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

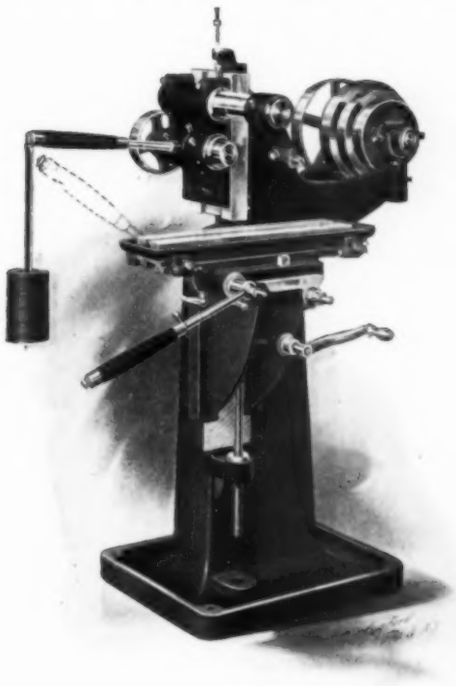
Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co. Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

"WHITNEY" CHAINS

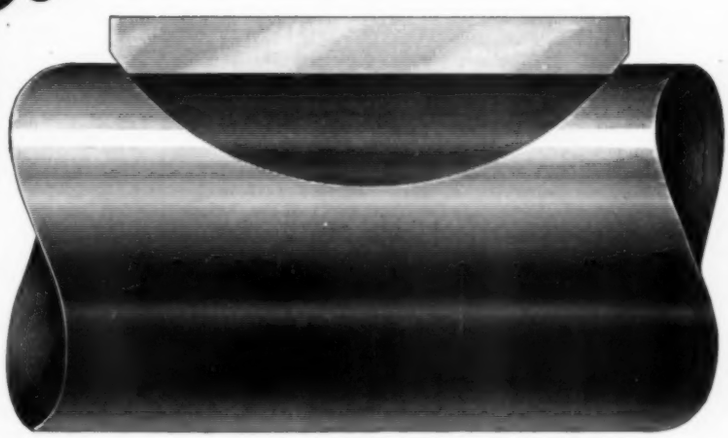
Hand (feed) Milling Machines

The Woodruff Patent System of Keying





The New Model.



The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Chucks, Lathe

Cushman Chuck Co. Hartford, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Bartlett, E. E., Boston, Mass.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Reed Co., Francis, Worcester, Mass.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Woods Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic

Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic

Sturtevant Co., B. F., Hyde Park, Mass.

Colleges

University of Cincinnati, Cincinnati, O.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Slushing

Warren Bros. Co., Boston, Mass.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.

Compressors, Air—*Continued.*

Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Ingersoll-Rand Co., New York.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Machine Co., Boston, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts

National Brake & Clutch Co., Boston, Mass.

Corundum

See Grinding Wheels

Cotters

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Veeder Mfg. Co., Hartford, Ct.

Countershaits

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.

Couplings, Shaft—*Continued.*

Chisholm & Moore Mfg. Co., Cleveland, O.
Davis Machine Co., W. P., Rochester, N. Y.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes

Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Phila., Pa.

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Krupp (Thos. Prosser & Son), New York.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Byram & Co., Inc., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.

Cutters, Milling—*Continued.*

Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Cyclometers

Veeder Mfg. Co., Hartford, Ct.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York City.
Safety Emery Wheel Co., Springfield, Ohio.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Globe Machine & Stamping Co., Cleveland, Ohio.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.
Risdon Tool Works, Waterbury, Conn.
Swaine Mfg. Co., Fred J., St. Louis, Mo.
Toledo Machine & Tool Co., Toledo, Ohio.

Dies, Sub-Press

Risdon Tool Works, Waterbury, Conn.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins

Winkley Co., Hartford, Conn.

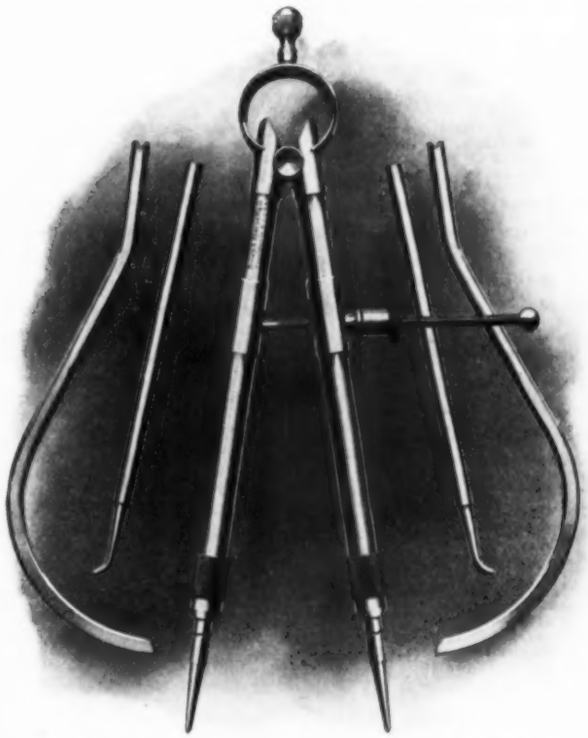
Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Mittineague Paper Co., Mittineague, Mass.
Rich, J. & G., Philadelphia, Pa.
Soltmann, E. G., New York.

BROWN & SHARPE MFG. CO.,

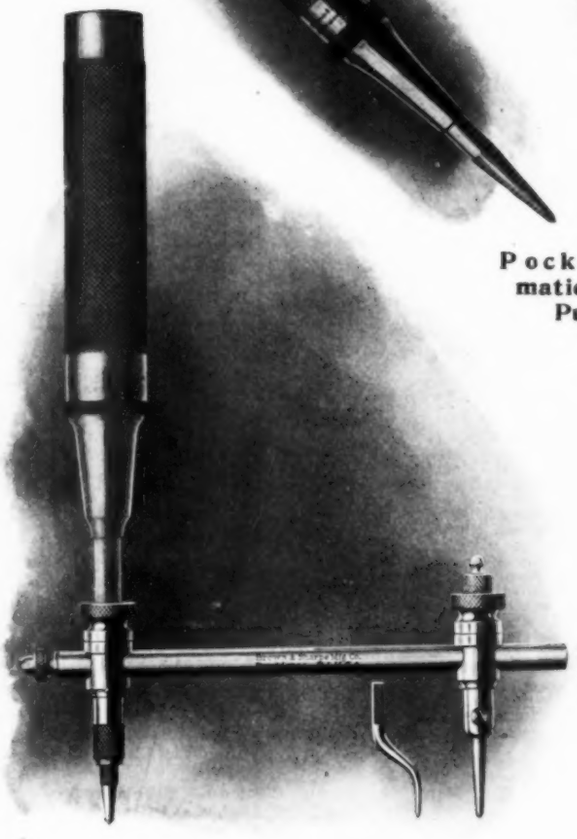
PROVIDENCE, R. I., U. S. A.

NEW
B. & S.
Machinists Tools.

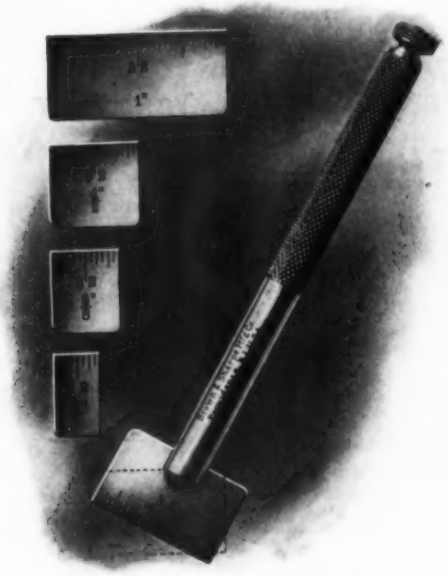


Combination Caliper and Divider.

Pocket Automatic Centre Punch.



Spacing Attachment.



Steel Rules With Holder.

New Circular, Describing These Tools, Sent Free To Any Address.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Mittineague Paper Co., Mittineague, Mass.
Rich, J. & G., Philadelphia, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Machine Co., The, Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., Francis, Worcester, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.

Drilling Machines, Radial —*Continued.*

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret

Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fenn Mach. Co., Hartford, Conn.
Fosnick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Machine Co., The, Hartford, Conn.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., Francis, Worcester, Mass.
Robertson Mfg. Co., Buffalo, N. Y.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center

Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.

Drills, Hand—*Continued.*

Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. Co., Chicago, Il.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels

See Grinding Wheels

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Mechanical and Electrical

Ballinger & Perrot, Phila., Pa.
Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Eng. Co., Stamford, Conn.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Oil

Remington Oil Eng. Co., Stamford, Conn.

Engines, Steam

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Garden City Fan Co., Chicago, Ill.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers

Bormay Engraving Co., New York.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Machinery Exchange, Boston, Mass.
Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric

Backus Water Motor Co., Newark, N. J.
Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Equipment of a Concrete Machine Shop

The General Equipment of the Buildings Devoted to Manufacturing in the Plant of the United Shoe Machinery Company at Beverly, Mass.

BY L. P. ALFORD

On page 723 is a general description of the buildings themselves, and it is the purpose of this article to deal only with the general features of the equipment, or with what might be properly called the permanent equipment of the main buildings. The equipment of the outlying buildings, the foundry, drop-forge shop and power house, will be left for later consideration.

Heating Equipment

The main buildings, and in general the entire plant, are heated by an indirect system. Direct radiation is, however, used to a limited extent in some of the tool-storage rooms of the wings, and in some rooms of buildings *C* and *G*. The fans, engines and heater coils for the main buildings, are located in the connecting wings. In the wings *A B S*, *A B N* and *B C* these fan rooms are below the ground-floor level in sub-basement chambers. In the wing *A B X* (the newer building) this heater room is on the ground-floor level. This change in location is due to the fact that the underground chambers are hot and unpleasant for the attendants. All of these fan chambers connect by means of a large tunnel with the power house, from which the supply of steam is received for heating. The fans are engine driven; the steam pressure is about 80 pounds. Steam for the heating coils is at a low pressure, varying from one to four pounds, as may be necessary for the amount of heat required. The exhaust from all the fan engines enters the low-pressure heating main, and thus adds to the supply for the heating coils.

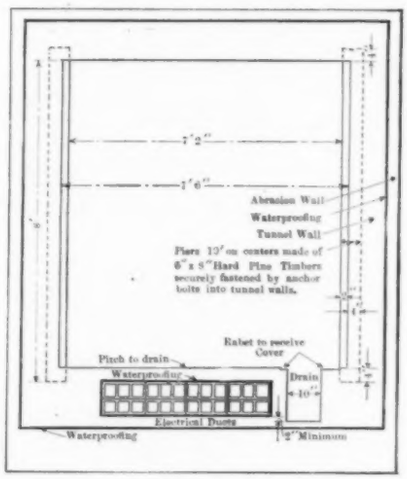


FIG. 1. CROSS-SECTION OF PIPE TUNNEL

The hot air from the fans is carried through concrete ducts below the ground-floor level, from which connecting ducts carry it to the flue columns on one side of each building. These flues connect with each floor by means of registers which are suitably controlled by mill dampers. Each fan has an independent fresh-air intake running to the roof of the building, thus insuring a supply of pure fresh air to the heating coils.

There is a re-circulating opening into each intake from each floor of the adjacent main building, so that if the plant is cooled down over Sunday or a holiday or for any other reason, it can be more readily heated by re-circulating the air until such time as the buildings are warmed to the proper temperature. When this is accomplished the air supply is taken from the roof, insuring a constant supply of fresh air for the manufacturing departments. A thermostatic system of control is established from the main floors to the heater-coil steam-supply valves, so that a change in temperature on the floors will regulate the supply of steam to the heater coils and also regulate the supply of cold air passing through a by-pass damper beneath these coils. This insures a uniformly regulated temperature. In general it is the intention to keep this temperature at about 68 degrees Fahrenheit.

In spite of the enormous glass area, with its radiation, no difficulty has been experienced in keeping the plant warmed even in the severest zero weather. The circulation of steam to the heater coils is by a vacuum return system which will establish a circulation of steam at about atmospheric pressure. All of the condensation from the heater coils is returned to the hot well in the power house. There is no system of ventilation for the main buildings outside of the offices, which are small rooms; reliance is placed upon the natural leakage from the buildings, and the constant supply of fresh air from the fans. In the hot weather in summer these fans are run to supply cool air to the buildings.

Pipe Tunnel

A pipe tunnel has been spoken of which connects all of the fan rooms, and in fact all of the buildings with the power house. There are in all about 1200 running feet of this tunnel, consisting of one main tunnel and three branches. These three branches cross the plant and connect with the fan rooms of the wing buildings.

These tunnels contain all of the pipe mains, with the exception of drinking water and gas, and the electrical cables for power and light. Fig. 1 shows a cross-section of the tunnel passing from the power house through to building *A B X* and is typical of the others. It will be noticed that the tunnel has ample width—7 feet 2 inches in the clear—to enable repair work to be done upon the piping, and also ample hight—8 feet—so that a man can stand erect at any point. This element of ample space is of vital importance; for a pipe tunnel which is too small is a nuisance, especially if there is heavy construction or repair work to be done. The pipes are fastened to the wooden timbers in the side walls. The steam pipes are on one side, and the water pipes on the other.

In the floors are placed vitrified clay conduits, which contain the various electrical cables. Suitable manholes are provided at intervals in the tunnel floor in order that the electrical mains may issue therefrom and connect with risers passing up through the buildings. In the floor of the tunnel will be noticed a drain or gutter at one side. The tunnel floor is pitched from its extreme end under building *A B X* back into the power station, so that if water reaches the tunnel from any source it is carried into the power-house basement to a sump hole, and then pumped to waste. While this tunnel floor is considerably below the level of mean high tide, and in fact below the level of the adjacent fresh-water reservoir, the amount of leakage is very slight, as the tunnel is carefully water-proofed throughout its entire length.

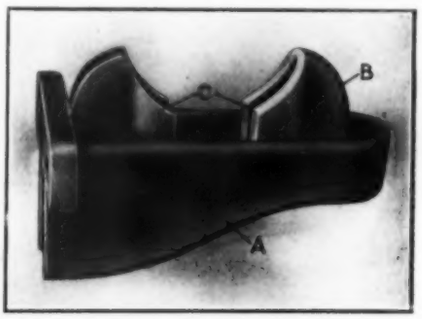


FIG. 2. PIPE-SUPPORTING BRACKET

Standing at the tunnel mouth in the power house and facing toward the tunnel, the pipes are arranged as follows: On the right-hand side beginning at the bottom, are the low-pressure steam main, the

intermediate-pressure steam main, and the return main from the vacuum pump in the fan room. On the other side, beginning at the bottom, are the elevator discharge main, the elevator supply main, the domestic water-service main, the compressed-air main, and the vacuum-pump suction from the direct radiation heating system. The pipes are supported on cast-iron brackets lag-screwed to the wooden posts anchored to the concrete walls. A half-tone of one of these brackets is shown in Fig. 2.

It consists of the base casting *A*, having a movable jaw *B*. This jaw can be clamped in any desired position to adapt it for the sizes of pipe within the range for which it was designed. At *C* are grooves, one in the jaw and the other in the main casting. If the pipe is subject to expansion, a roll is fitted between the jaws and held in position by trunnions entering the grooves. The expansion and contraction of the steam lines is cared for by expansion joints placed at intervals throughout the tunnel system.

Neither the gas main nor the drinking-water main is carried through this tunnel. The gas supply comes from the city works, and enters the building above the ground-floor level. The drinking-water supply also comes from the city, and is not carried through the tunnel because of the temperature. This temperature, although the steam pipes are covered, averages from 100 to 110 degrees Fahrenheit, and this would render the drinking water unfit for use.

Toilet Rooms

The toilet rooms are well arranged and equipped for factory use. The sanitary stalls are of slate; the utilities themselves are all of heavy porcelain, and the plumbing is at all points open and accessible for the purposes of cleanliness and repairs. A washing sink in the corner is supplied with both hot and cold water, and is for the use of the janitor and employees who may find it necessary to wash during regular working hours, as the general wash rooms are locked each day between the hours of 7:30 and 12 and 1:30 and 6.

Figs. 3 and 4 show a wash room and a locker room. The important features are the individual wash bowls, the shower baths, and the metal lockers. There are sufficient lockers so that each man may have one for his individual use. The number of wash bowls is roughly about one-half of the number of employees, as it is found that a certain number of men prefer to wash at home, and there is a chance for one man to follow another; thus the same bowl may be used more than once at each washing-up time. These bowls are supplied with tepid water at from 110 to 115 degrees Fahrenheit. This water before reaching the wash-bowl supply pipe passes through a throttling cock which controls the flow.

The tempered water comes from a large heating tank located in the fan room below. This tank holds about 4000 gallons, and is provided with steam nozzles or jets under thermostatic control. As the noon hour approaches, this tank is filled with water at the right temperature for the washing supply. From seven to ten minutes of 12 and again from seven to ten minutes of 6, the janitor in charge turns water into the bowls. It is intended that each bowl shall be nearly full of water at 12 o'clock and at 6 o'clock. The water is then allowed to run until ten minutes past the hour in each case. Thus when the employees come in to wash, each wash bowl is filled with tempered water, and there is a running supply, so that after the water in the bowl is soiled from washing their hands they can obtain clean water from the running stream for use in washing their faces.

The shower baths are supplied with both hot and cold water, the hot water at about boiling temperature. Both the hot and the cold water are supplied to the shower baths through a mixing valve, so that each bather can have water at the particular temperature which he desires. These baths are free to employees, but are used on the employees' time. It has been found by experience that they are used a great deal during the summer time, but not so much in winter. The lockers are

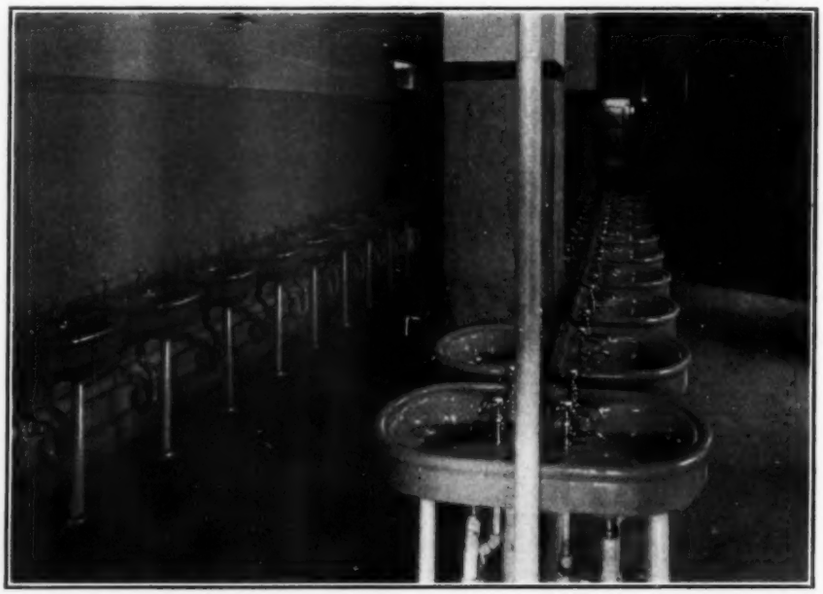


FIG. 5. WOMEN'S WASH ROOM

FIG. 3. A WASH ROOM

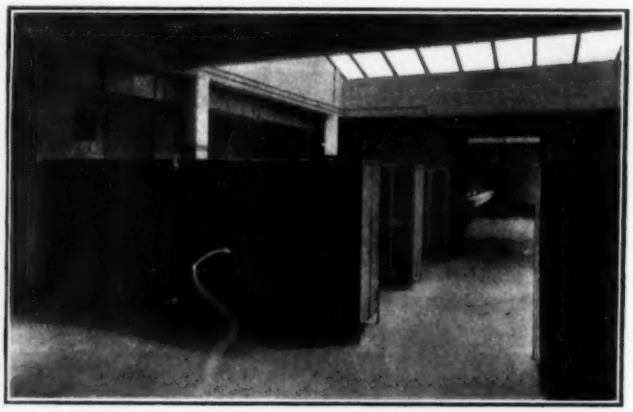


FIG. 4. A LOCKER ROOM

entirely free for the use of employees; the only restriction is, if a key of a locker is lost it shall be paid for.

Fig. 5 shows the women's wash room. This wash room is provided with enameled wash bowls supplied with both hot and cold water, and has individual bath rooms provided with tubs. The locker facilities are the same as for the men.

All of the toilet, locker and wash rooms have a forced ventilation system. Concrete flues connect each room with a foul-air chamber under the roof. The air from this chamber is discharged by a motor-driven fan. In the newer part of the plant the toilet-room ventilation is taken through the utilities themselves and thence into the flues.

Drinking-water Supply

Drinking-water fountains are located at frequent intervals throughout the manufacturing departments, and are supplied with a running stream of water. This water passes through a throttling cock and runs a small stream constantly, so as to keep the supply cool. In summer it is iced.

Sewers

Two systems of sewers serve all parts of the plant. One, termed the "sanitary" sewer, communicates with the general sewerage system of the city, while the "storm"-water sewer receives the roof drainage, surface drainage, and drainage from the drinking-water fountains and other minor utilities. This storm-water sewer empties into a basin near the tide gate. The arrangement is such that this basin is emptied at every tide. The system is carefully laid out, and provided at all necessary points with manholes and catch basins, so that any part can be rodded or cleaned out in case of necessity.

Motor Equipment

Power is transmitted electrically for all purposes throughout the plant. The machine tools are arranged in groups and under a system of group drive; that is, a certain amount of main-line shafting either for an individual department or for adjacent departments is driven by a motor. The plant is operating in all about 50 motors of various sizes ranging from 1 horse-power to 75 horse-power; the common sizes are 20, 30 and 40. There are few cases of individual drive, with the exception of blowers and exhausters, which are connected to motors by gearing or belting.

This question of driving was carefully investigated before the plans for the plant were made, and it was determined that there was no advantage in using individual motors, as the machine tools are small. There were, however, many advantages for electric group driving. The motors are induction motors, three-phase, 60 cycles, 550 volts, and in general are of the internal-resistance type. Fig. 6 shows a motor in place on the ceiling—for practically all of the motors are ceiling suspended—and its connection to the line shafting. A countershaft is at the left, but does not show in the illustration. As the motors are of high speed compared with the speed of machine-shop shafting, in almost every case countershafts had to be used in order to make at least one reduction between the speed of the motor pulley and the speed of the line shaft.

Another motor and its shafting are shown in the half-tone Fig. 7. Here no countershaft is necessary, as the line-shaft speed is high enough to allow belting direct from the motor pulley. The method of suspending the motor is of interest. Small channels, back to back, are strapped to the concrete floor members and form a structure to which the machine is bolted. No sliding base is used. There is freedom enough in the space between the channels to square the motor with the shaft. In bolting through a concrete beam in this way, care is used to pass the bolt through the upper zone of the member well above the neutral axis.

Near each motor, at some convenient place, either on the wall or post, is a switch, protected by a cabinet or box, provided with suitable fuses and acting as a point of control and safeguard for the individual motor. On the top of each of these switch boxes are three 200-volt incandescent lamps wired in series, arranged so that when there is current on the line and the motor is not running these lamps glow. This is a safety device so that the foreman will not try to start a motor when the mains are dead. The switch box shows plainly in Fig. 7. It is located on the column near the motor. The foremen of the various departments are responsible for the starting and stopping of their motors. A printed set of instructions is near each switch box for the foreman's guidance.

To Start a Motor:

Be sure that resistance operating lever is pushed up as far as it will go. As soon as pilot lamps on switch cabinet glow, throw in operating switch with a firm, quick movement.

FIG. 6

FIG. 7

MOTORS AND SHAFTING

The motor should start immediately.

Then pull down the resistance operating lever slowly, bringing it fully down in 5 or 6 steps, and during an interval of 15 to 20 seconds from the time the motor begins to rotate.

To Stop a Motor:

Throw out operating switch. Then push up resistance operating lever as far as it will go.

In General:

Never throw in the operating switch until pilot lamps glow.

Never throw in the operating switch unless resistance operating lever is pushed up as far as it will go.

Never push up the resistance operating lever when the operating switch is in the running position.

Never open the switch cabinet.

In case the operating switch is thrown in and the motor does not start, throw out the switch *immediately*, and notify the electrical department.

In case a motor stops during running hours, throw out the operating switch and push up the resistance operating lever *immediately*, and notify the electrical department.

In case a motor shows signs of distress, throw out the operating switch and push up the resistance operating lever *immediately*, and notify the electrical department.

No trouble whatever has been experienced in operating the motors in this way, although mistakes connected with the starting and stopping might result in a burn-out.

The power cables pass through the clay ducts in the tunnel floors, starting at a point in the power house beneath the switchboard, which is the general point of distribution for both the power and lighting circuits. The cables pass throughout the entire tunnel and run to such places as are necessary for risers. These risers pass up through the buildings and feed to horizontals on a wire structure running lengthwise of each one of the main floors and near the ceiling. From these horizontals on each floor, taps are taken off to the motors.

Fig. 8 is from a photograph of the wire structures. It consists of a rack made of 5-inch channel beams placed vertically with their flanges facing. Between these

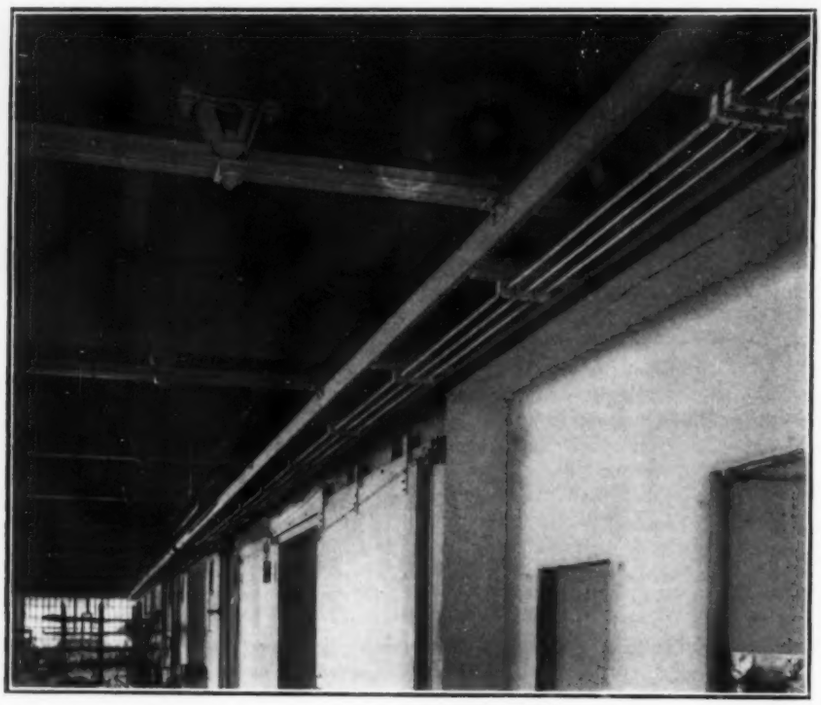


FIG. 8. WIRE STRUCTURE

channels are cross bars of wood; to these cross bars, both top and bottom, are cleated the wires. This structure is also used for telephone wires, signal wires and in fact wires for all purposes throughout the plant.

ARTIFICIAL LIGHTING EQUIPMENT

The current is generated three-phase, 60 cycles and at about 575 volts, thus affording a proper pressure for the 550-volt induction motors. In order to make use of this current for lighting, it is distributed to convenient points throughout the plant and then is stepped down in voltage to 110. It is then used for both incandescent and arc lights.

In general the lighting throughout the plant is by means of 16 candle-power incandescents; the only exceptions are that higher candle-power lamps are used in some of the offices and drawing rooms and a certain number of arcs are used for general illumination, such as around elevators and at the ends of the main passages. Most of the arcs are of a size requiring 7½ amperes of current.

The transformers are located on the outside of the buildings. There are three kinds of lighting circuits for the plant, having independent control from the power-station switchboard. These are called the *day circuits*, *public circuits* and *machine-tool circuits*. Their names are an indication of their use.

The day circuit provides light for the offices, drawing rooms, tool rooms and other locations which are liable to be dark or liable to demand artificial light at any time. Individual switches for the various rooms control this circuit so that light can be furnished in any one room independently of the others. The public circuit lights the main passageways lengthwise of the manufacturing buildings, all of the stairways, toilet rooms, locker and wash rooms, wing passageways and yard. In general this public lighting is not used during the manufacturing hours. It is used morning and evening during the season of the year when lighting is necessary when the employees are entering and leaving the plant. Its con-

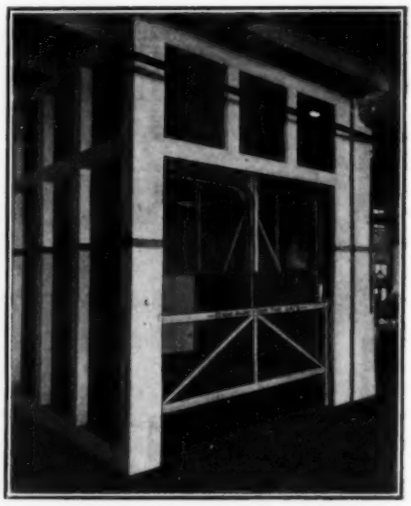


FIG. 9. ELEVATOR CAR AND WELL

trol is entirely from the switchboard, with the exception of the locker, wash and toilet rooms, each of which is controlled by its own switch. This control is of advantage in connection with overtime work or work under unusual conditions when only a portion of the plant is operating.

The machine-tool circuit is used entirely for machine-tool lighting, that is, for the individual lights on machine tools. This circuit controls nothing but incandescent lights. In addition to the switch control in the power house, each one of the main manufacturing floors is divided into six sections lengthwise of the building and controlled by a switch in a switch cabinet located near the tool-room windows. Thus every section of any one of the main floors, of a length approximately 150 feet long, can be lighted at will.

The lighting taps are carried across the building in wooden molding. Lights for the individual machine tools are either drops or adjustable fixtures, preference being shown for the adjustable fixture. The method of supporting the molding from the concrete beams is described in an article on page 367. When all of the machinery is installed in the newer part of the plant and equipped with lights, there will be in use about 10,000 incandescent and 150 arcs. A small amount of direct current is used at a voltage of 110. It is obtained from a small isolated plant having a motor generator set and located in one of the main buildings. It is used in magnetic chucks, for blue printing and for some special variable-speed motors used for testing in the experimental department.

Main-line Shafting

The main-line shafting is of steel running in Hyatt roller bearings. Its arrangement is shown in Figs. 6 and 7. The bearings are spaced 10 feet on centers. The standard shaft diameter is 2 3/16 inches. This size is used uniformly for all line shafting, except some head shafts where a large size is needed. The couplings are all of the flanged faced type.

Time-keeping System

An electric time-keeping system is installed throughout the entire plant. The clocks are located in general near the toolroom windows. They are under the control of a master clock located in the office. This clock also controls a program clock, and this program clock controls a series of gongs throughout the plant and a whistle-blowing valve on the main whistle at the power house.

These gongs ring at five minutes before the time of starting work, at the time of starting work, and at the close of work. One circuit is for the general factory employees; another circuit is for the women employees, as they are allowed to enter the plant ten minutes after the time for commencing work by the men, and are permitted to leave the plant ten minutes before the men.

A third circuit is for the employees in the general offices, and a fourth for the drawing-room force. This system insures uniform time throughout the entire plant. It is also used for synchronizing the time registers.

Elevators

The elevators are of the plunger type and are eleven in number. They are located to serve all departments. The general size has a car about 8x10 feet, and a lifting capacity of about 6000 pounds. There is, however, in the receiving department one large elevator having a car 10x16 feet, and a lifting capacity of 12,000 pounds. This is for use in handling large machine tools between the various floor levels. The water for operating these elevators is supplied by a pump in the power house. The water pressure is 150 pounds per square inch. Near the center of distribution is a small auxiliary pump and two large tanks containing air to aid in equalizing the pressure at the extreme end of the system. Fig. 9 shows an elevator car and well.

Dust-exhausting Systems

Fig. 10 shows a fan exhauster, its piping, method of driving and the dust separator. This system is located in the pattern shop, and is typical of the dust-removing installation for all departments having either wood dust, felt lint, or emery dust from the manufacturing operations. The separator is vented through the roof and discharges from the bottom into a large collector from which the dust is removed at intervals.

The feature of ceiling suspension for both motor and exhauster is worthy of notice.

Some of the features of the installation and equipment which have been described are novel in their treatment. All of them are well worked out, and are worthy of consideration, as showing what can be done by developing and carrying out a consistent scheme in a manufacturing plant. They are of further interest as showing the specific methods of construction which were used in buildings of reinforced concrete.

FIG. 10. DUST EXHAUSTER AND PIPING

Technical Literature

Not least among the attractions offered to visitors by the Jamestown Exposition will be the opportunity of securing, gratuitously, publications of both general and technical interest such as are issued by various industrial companies of the country for the information of the public. Among these one of the most attractive will be a pamphlet entitled "Allis-Chalmers Engines at Home and Abroad," which is unique from the fact that it contains 68 large pages without reading matter, except brief descriptions underneath the cuts and a list of the company's products at the end.

Special Apprenticeship

Believing that the subject will be of large interest to our readers, we give below the special features of the special apprenticeship system outlined in the report of the apprenticeship committee of the National Association of Machine Tool Builders, at the Fortress Monroe meeting. Those portions of the report which pertain to the formal agreement between the parties are omitted, as they do not differ essentially from existing apprenticeship methods. It will, of course, be understood that the report, not having been adopted yet, all of its terms, including those given below, are subject to modification.

A trial period of 240 hours will first be required, after which should the apprentice prove satisfactory, he will enter his term of service, which will be computed from the beginning of the trial period. The wages of the apprentice during the period shall be the same as paid for the first period for the branch herein specified.

If during this trial period, an apprentice should, in the opinion of the company, prove deficient in capacity or unsatisfactory in deportment, notice to that effect shall be given to said apprentice and his surety, and the contract of apprenticeship shall become absolutely void.

On completion of the trial period, the apprentice will be given the use of a new equipment of tools adapted to the work upon which he is employed, which will be the property of the company; but on satisfactory completion of the term of apprenticeship, said equipment of tools will be given to the apprentice free of charge.

The branches of the machinists' art and trade, with the respective number of working hours required, inclusive of trial period, and the wages per hour, are as follows:

Turning—Two years of 2900 hours each. Wages, 12c. per hour first period of six months; 14c., second; 16c., third; 18c., fourth.

Vertical Boring Mill—1½ years of 2900 hours a year. Wages, 15c. per hour first period of six months; 17c., second; 20c., third.

Horizontal Boring Mill—1½ years of 2900 hours a year. Wages, 15c. per hour first period of six months; 17c., second; 20c., third.

Planing—1½ years of 2900 hours a year. Wages, 12c. per hour first period of six months; 14c., second; 16c., third.

Milling—1½ years of 2900 hours a year. Wages, 15c. per hour first period of six months; 17c., second; 20c., third.

Drilling—One year of 2900 hours. Wages, 15c. per hour first period of four months; 17c., second; 20c., third.

Grinding—One year of 2900 hours. Wages, 15c. per hour first period of four months; 17c., second; 20c., third.

Erecting—1½ years of 2900 hours a year. Wages, 15c. per hour first period of six months; 17c., second; 20c., third.

Turret Machine—One year of 2900 hours. Wages, 15c. per hour first period of four months; 17c., second; 20c., third.

Vise Work—1½ years of 2900 hours a year. Wages, 15c. per hour first period of six months; 17c., second; 20c., third.

Scraping—1½ years of 2900 hours a year. Wages, 15c. per hour first period of six months; 17c., second ; 20c., third.

Special apprentices who have completed their terms of apprenticeship, wishing to become regular apprentices, may do so upon executing the articles of agreement; the time served as special apprentice shall entitle said apprentice to such credit of time on period of service as regular apprentice, and an increase in wage rates, as may be mutually agreed upon.

Elements of Tool Design

By Smokey

It has been my lot to have something to do with the designing of jigs, tools and fixtures during the last few years, and I know that most draftsmen are not very fond of this class of work. They seem to think, "Oh, well! this job is good enough until something better turns up." We have tried many schemes to convey our system and practice to these men. We give a new man definite instructions on one jig and it works all right, but on the very next job this same scheme is no good; but the new man will use it because he was told to put it on the first one.

Below are a few of the questions that must be taken into consideration on every jig:

How many pieces are to be made?

Do we need a good, medium or cheap jig?

What is the best general style?

Shall it be made from solid stock or built up?

How many pieces are to be held at one setting?

Can the work be put into the jig without any false motions on the part of the operator?

Can the work be taken out of the jig readily?

Can the work be clamped without marring or springing it?

Has due allowance been made for any variations in the pieces?

Has the work been gaged from the correct place?

Do all bushings come close to the work to guide the drills?

Is there any place where dirt or chips are liable to collect and throw the work out of true?

Does the title of your drawing show absolutely what the tool is intended for?

Getting Back to the Beginning of Things

By Dixie

Every now and then some alleged genius brings out something that's going to "revolutionize things," something that is perfect from the start. I used to believe these inventions were possible, and hope that I, too, some day might develop one; but the older I grow the less I believe in perfection attained over night. It can, I think, with truth, be asserted that anything that is worth while is the result of evolution.

I recently took a run through the central part of Pennsylvania. Among the high spots, which I would advise anyone mechanically inclined to hit, is Lancaster.

It is a very old city, as age goes in the United States, having been a settlement before William Penn's time, and of considerable importance as a manufacturing center. I found quite a number of things, which I had always considered modern, had their origin in Lancaster over a hundred years ago.

Ball bearings are, I believe, generally supposed to have been invented within the past 40 or 50 years, but the old Trinity Lutheran church, Lancaster, has a weather vane, which was put there in the eighteenth century, hung on ball bearings. I was told that it had never been taken down nor cleaned, and that it is the only reliable vane in the city. I can vouch for its being very sensitive. In a cigar store on King street I found two very interesting primitive tools, both of which were made in the eighteenth century.

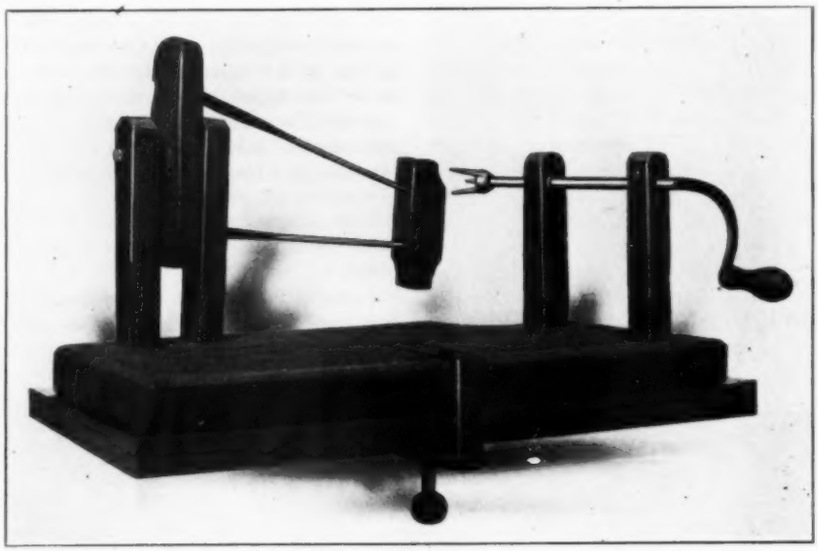


FIG. 1. THE OLD APPLE PARER

We are all familiar with the little 25-cent cast-iron apple parer; I found its great-grandfather, and promptly took him off to get him photographed. Fig. 1 shows the apple parer. The three prongs for holding the apple are the same as in modern parers. The base is made of wood with an iron clamp to secure it to a table. The standards for supporting the spindle are also of wood, with a couple of wires to keep the spindle from being lost. The knife is similar to that used in wooden spoke shaves. It is mounted in a wooden head, a piece of brass being fastened in front of the cutting edge to prevent the wood from being worn. Judging from the way the brass shield was worn, quite a number of apples must have been pared on it.

The wooden knife block is driven on two round steel wires about 3/16 inch thick. At the other end these wires are

FIG. 2. THE OLD HAIR CLIPPERS

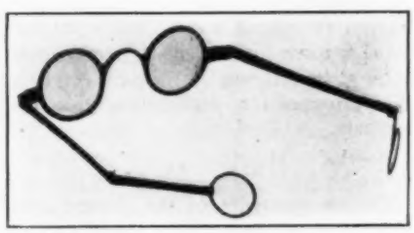


FIG. 3. THE OLD PAIR OF SPECTACLES

flattened and driven into another block of wood. A trunnion in the center permits the block of wood to swing. The apple is mounted on the three prongs. The right hand turns the crank and the left hand supplies the feed, which in the modern parer is automatic.

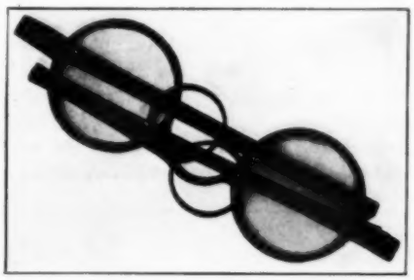


FIG. 4. THE SPECTACLES FOLDED

At Fig. 2 are shown two views of the forerunner of the hair clipper shown at page 302 in Brown & Sharpe's catalog—a stanch New Englander who is at this writing looking over my shoulder, says that the originator of the Brown & Sharpe clipper was a New England darky, who died recently. Be that as it may, this clipper was made in Lancaster about 100 years ago by the senior Leaman, the rifle-maker.

The handles are made of brass, with the steel serrated cutting blades riveted on. The member at the back, with the thin teeth, is a gage. It is made of spring steel and had at one time an adjusting screw to force it away from the clipper. The old clipper is in good condition—I cut my mustache with it.

Figs. 3 and 4 show an old pair of spectacles I picked up in a junk store for 50 cents. I could not get the history of them, except that they were made by a local blacksmith who shod horses, made wagons, repaired farm implements and made spectacles in the latter part of the eighteenth century. The lenses are a trifle scratched, but I can read nearly as well with them as I can with my fancy bifocals I got the other day—I suppose they don't know my eyes are astigmatic.

The lenses and temples are secured in the frame in the same way that modern ones are, by a binding screw and pivot for each temple. The material of the frame and hinged temples is evidently spring-tempered steel. They are not nearly as heavy as they look, and weigh only ¾ ounce.

Muskets were made here for the Continental army by Leaman. The first screw auger was invented here by Rauch and William Henry. Baron Stiegel, a wealthy iron master, had furnaces in the neighborhood. He reduced himself to comparative poverty during the Revolutionary War by advancing money to the Continental army. Some examples of his foundry work are still in existence in the shape of cast-iron gravestones, if I may use the term, and stove plates.

Fig. 5 shows one of these stove plates. The wonder is that it survived, for in the center the head of George III appears in bas-relief, and during the Revolution Georgie's mug was not popular.

But Lancaster is not a has-been; it's a live town, where things are done. The Hamilton watch factory is there, where they make high-grade watches only, from three to four hundred of them a day.

The Hubley Manufacturing Company's plant produces some of the finest small castings I have seen—clean, strong and easily machined. Iron toys, such as trains, fire engines, etc., are made here by the thousand. During the busy season 30,000 complete toys a day are turned out besides the other work.

Fig. 6 shows an old cupola, standing in a near-by village. It was operated in the early 40's, built on the separate type plan; that is, the lower part was built on a base and the part bearing the stack was built separate at about the level of the charging floor, being supported on iron columns. The blast was led to the cupola by a leather pipe shown in the illustration. The open brickwork in the upper part was for the object of cooling the slack.

FIG. 6. AN OLD TIME CUPOLA

FIG. 5. CAST-IRON STOVE PLATE MADE IN 1769

The Unexpected That Often Happens

By John E. Sweet

A centrifugal pumping plant has been put in near Cairo to pump sand from the Mississippi river bed to fill in a tract of land, but it can only be worked when the river is at a certain stage.

The plant was installed at the wrong time, but to try it they simply turned back the discharge into the river and found the engine would not drive the pump.

When the time came to use the plant, 2000 feet of pipe was connected, as was the original design, and the engine drove the pump all right and discharged the water and sand at the end of the 2000 feet in a quantity quite beyond the stipulated amount.

This I am told by the builder of the plant. It looks inconsistent, but it may be as simple as the short-circuiting of an electric generator which brings an engine up standing

A foundry and machine company has been formed at Sydney, Nova Scotia, with a capital stock of $100,000.

The Tokyo Industrial Exhibition

Outlining the Purpose of the Exhibition, the Industries to Be Represented and Showing What Was Done in a Few Months

BY CHARLES A. FRANCIS

The idea of holding an industrial exhibition in Tokyo is, I believe, only a little more than a year old. It was started from a suggestion that Tokyo, as the first city of the Japanese empire, should do something to celebrate the return of peace. To judge by what came under my observation in the course of say three hours, while being shown through the different buildings and grounds in company with fully four thousand invited guests, I wondered at the success with which everything had been done, for one must take into account the short time that has elapsed since the late war, also the eight or nine months in which the grounds were laid out and the buildings put up.

FIG. 1. MAIN ENTRANCE

FIG. 2. AGRICULTURE, FORESTRY, MARINE, ETC.

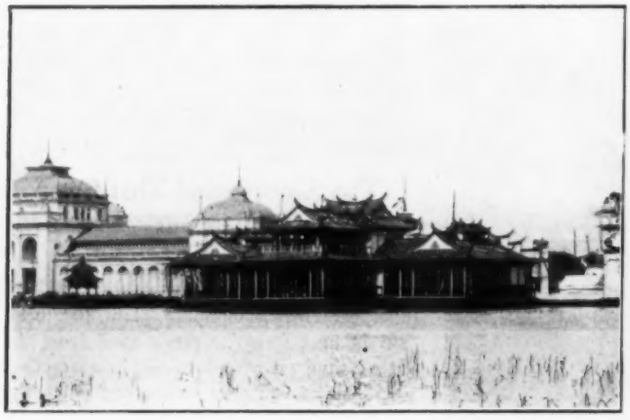


FIG. 3. FORMOSA BUILDING

FIG. 4. FOREIGN BUILDING

Opening Ceremony

This morning (March 20) Uyeno park, some four miles from the center of the city, became the Mecca of three or four thousand invited persons, who traveled in carriage, jinrikisha, and train. The sun shone brilliantly, and there was every promise of fine weather throughout the day.

Immediately upon entering the main entrance to the exhibition the guests assembled under a large awning, at one end of which was a raised platform, from which the inaugural speeches were to be made. The platform, which was appropriately decorated, was occupied by a large gathering of distinguished persons, including Prince Kan-in and attendants, Baron Senge, governor of Tokyo, Mr. Ozaki, mayor of Tokyo, Mr. Matsuoka, minister of agriculture and commerce, and practically the whole of the corps diplomatique.

The discharge of fireworks, followed by the martial strains of the "Kimigayo," from a military band, marked the hour (10 o'clock) of the beginning of the ceremonies.

The speeches, some six in number, were very brief, and in less than three-quarters of an hour the whole throng, led by the governor and platform guests, was filing through the various buildings of the exhibition, the contents of which, though in a somewhat incomplete state, were well worth seeing.

Toward 1 o'clock the guests made their way to the refreshment booths, some fifty in number, and partook of lunch, served by attractive waiting girls.

Opened to the Public

The exhibition was opened to the general public at 2 o'clock, and will be open every day till July 31, from 7 a.m. till 6 p.m. The price of admission tickets will be 10 sen* on week days, and 15 sen on Sundays and national holidays, tickets for children between 6 and 12 years of age being sold at 5 sen on week days, and at 10 sen on Sundays and national holidays.

It is understood that the plans as laid

out for the Tokyo industrial exhibition are on a larger scale than were those of the national exhibition held at Osaka, in 1903. The remarkable development of the country in commerce and industry after a victorious period of warfare will be, I believe, fully displayed in the exhibition, and for the benefit of the readers of the AMERICAN MACHINIST, the following information regarding the several buildings and grounds is given:

EXHIBITION GROUNDS

The exhibition is situated in Uyeno park†, and grouped around Shimobazu pond. The grounds are divided into three compounds. The first compound is located in front of the Imperial Museum (Takeno-dai), and extends over Cherry hill (Sakuraga-oka). This covers the main part of Uyeno park. The second compound comprises the whole of the ground surrounding Shimobazu pond, the northern part being divided from the southern part by two gates, the latter part being given up to various small shops where are to be found various small articles for sale. The third compound is in front of the Imperial Library.

SOME OF THE BUILDINGS

The principal exhibition buildings are some sixteen in number, and nearly all are only one story in hight. The main building, No. 1, is U-shaped; over the entrance of it is mounted a mosque-like tower about 50 feet high. On the front and just over the main entrance is the name "Tokyo Industrial Exhibition." In the left wing of this building are to be found exhibited chemical products, porcelains, minerals, lacquer ware, wood and bamboo ware, furs, leather goods, shells and horns, and other decorative and useful objects. The greater portion of the right wing is occupied by exhibits relating to education. This building covers 1981 tsubo.‡

Building No. 2, forming an extension to the left wing of the main building, and covering 1248 tsubo, is to be preserved after the exhibition. Its structure has therefore been made much stronger than that of any of the others. The floor of the building is paved with artificial stone. The exhibits here include goods relating to agriculture, horticulture, forestry, hunting, marine industry, and civil engineering.

FIG. 5. MITSU BISHI BUILDING

FIG. 6. MACHINERY BUILDING

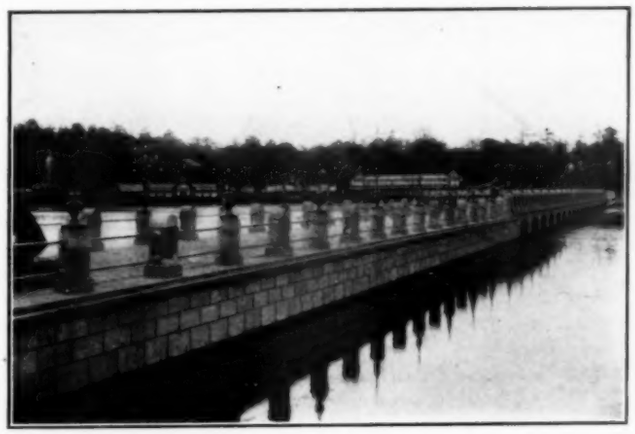


FIG. 7. BRIDGE TO ISLAND IN POND

FIG. 8. FISHERY BUILDING

TEXTILE INDUSTRIES

In the Textile Manufacturers' building are the exhibits of silk, embroideries, dyed stuff and dresses. It is understood that the textile manufacturers have been taxing their brains for some time in making designs for the most effective displays of their goods. The exhibition will no doubt prove the most attractive of any to the ladies.

*Currency—The values are decimal, with the yen, equivalent to about two shillings English, or 50 cents U. S. gold, as the unit. One yen contains 100 sen, one sen contains 10 rin. The currency consists of gold, which is practically never seen; of silver pieces of 50 sen, 20 sen, 10 sen and 5 sen; of nickel pieces of 5 sen; of copper pieces of 2 sen, 1 sen, 5 rin and 1 rin, besides others issued during feudal days, representing 1½ rin, 8 rin (these are oblong pieces called tempo, now rarely seen), etc.; and paper money worth 1 yen, 5 yen, 10 yen, and various larger sums.

Exchange quotations—March 20, 1907, London bank demands 2 shillings 7/16 pence; New York and San Francisco banks demand 49⅜ cents.

†Uyeno park, with its temples and tombs of the Shoguns, is the most popular resort in the metropolis, especially in April, when all Tokyo assembles to admire the wonderful mass of cherry blossoms for which it is famous. The importance, however, of Uyeno is dated many years back, and is owing to the fact that it lies due northeast of the palace. Formerly there was a widespread superstition which regarded that quarter as the most unlucky of all the points of the compass, and branded it with the name of Ki-mon, or the Demons Gate. After some progress had been made in the construction of the city Yedo, the Shogun Iemitsu, in the year 1625, determined to erect here a set of Buddhist temples, which, eclipsing all others in splendor, should ward off the approach of such evil influences. The original main temple (Kwan-eiji) occupied the site of the present Imperial Museum, and was burned down in 1868.

‡Land measure (tsubo)—The unit is the tsubo, nearly equivalent to 4 square yards English. An acre is nearly equivalent to 1210 tsubo. One cho = 2½ acres, and 1 ri (square) = 6 square miles, approximately.

The Fine Arts building is probably the most attractive from the outside of any, being a fine specimen of architecture. In the central part is a large dome, surrounded by four smaller ones. The lighting of the interior has been carried out with very good effect. The exhibits include Oriental pictures, foreign paintings, sculpture, plaster images, relief work, etc. The progress in fine arts in Japan after the fifth national exhibition is fully displayed here.

An Odd Building

On entering the second compound of the exhibition the first thing that attracts the eye is what is called the Formosa hall, No. 3. It is constructed after the model of a public hall in Formosa, and presents a queer sight in contrast with the other buildings of foreign construction. The building is two stories in hight, one-half extending out over Shimobazu pond. The interior is painted blue, yellow, white, red and black. At night the building will be illuminated with electric lights, 1500 candle-power being used. Formosan products are on exhibit here, among which were noticed a bamboo measuring a little over 2 feet in diameter, a bean cake 2 feet long, and a camphor tree 6 feet in diameter. The second floor will be used as a tea room, where Oolong tea will be served.

Foreign Exhibits

Foreign Exhibits building, No. 4, is a large U-shaped building covering 1512 tsubo, in the central part of which has been erected a three-story tower. The second floor is used as a reception room. From the third floor a fine view of Shimobazu pond and the surrounding grounds can be had. On the main floor of this building will be exhibited engines, boilers, textile goods, clocks, watches, dyed stuffs, toilet articles, wines, musical instruments, crockery, etc., all of foreign make, the exhibitors in this building being practically all foreigners. This building has been made for permanent use after the fair, and cost 150,000 yen.

The queer-shaped building, No. 5, situated near the left wing of the Foreign building, is known as the Mitsu Bishi House. It is of foreign construction, mounted by a spherical dome, surrounded by triangular spires. The latter are painted in colors. The dome is mounted by a female figure with a hammer in the left hand and laurels in the right. Among the principal things seen here were models of three steamers now in process of construction at Nagasaki ship yard, Kobe; minerals from Sado and Ikuno; gold, silver and copper ores.

Machinery Hall

Machinery hall, No. 6, is a well-lighted building of wood construction. Power (about 750 horse-power) for running the machinery in this building will be furnished from the central power plant.

The new bridge, No. 7, connecting the shore of the pond with the small island, where is a shrine dedicated to the beautiful goddess Benten, is called Kangetsu-kyo (moon-viewing bridge), and measures 600 feet in length, and 19 feet in width. This bridge will be profusely illuminated at night with hundreds of electric lights.

The Tokyo industrial exhibition will do credit, I believe, to a far more pretentious undertaking of national character.

Diagram for Finding the Strength of Bevel Gears

By H. T. Millar

When computing the strength of bevel gears from the "Lewis" formula, two of the factors have to be modified. One is, of course, the pitch, which must be the mean, not the nominal, pitch. As the mean pitch varies with nearly every combination of gears of a given pitch, and also with the length of tooth face, it is impossible to embody it accurately in a diagram. The factor *y*, which varies with the shape of the teeth, should also differ from the one used for spur gears of similar numbers of teeth; the causes of this difference may be seen from study of Fig. 1, on which are shown the pitch cones of two gears and their projection on a plane perpendicular to the plane of tooth action. It will be seen that the mating surfaces, so far as tooth action is concerned, are parts of ellipses. It can be shown that the radius of curvature R in an ellipse at the extremity of the minor axis is a third proportional to the semi-minor and semi-major axes.* From this fact it follows that R (th radius of a wheel for which y must be chosen) $= \frac{Radius\ of\ gear}{\cos\ B}$, and on this basis the diagram has been worked out. This diagram will do for spur gears also, treating them as bevels with a cone angle of 0 degrees.

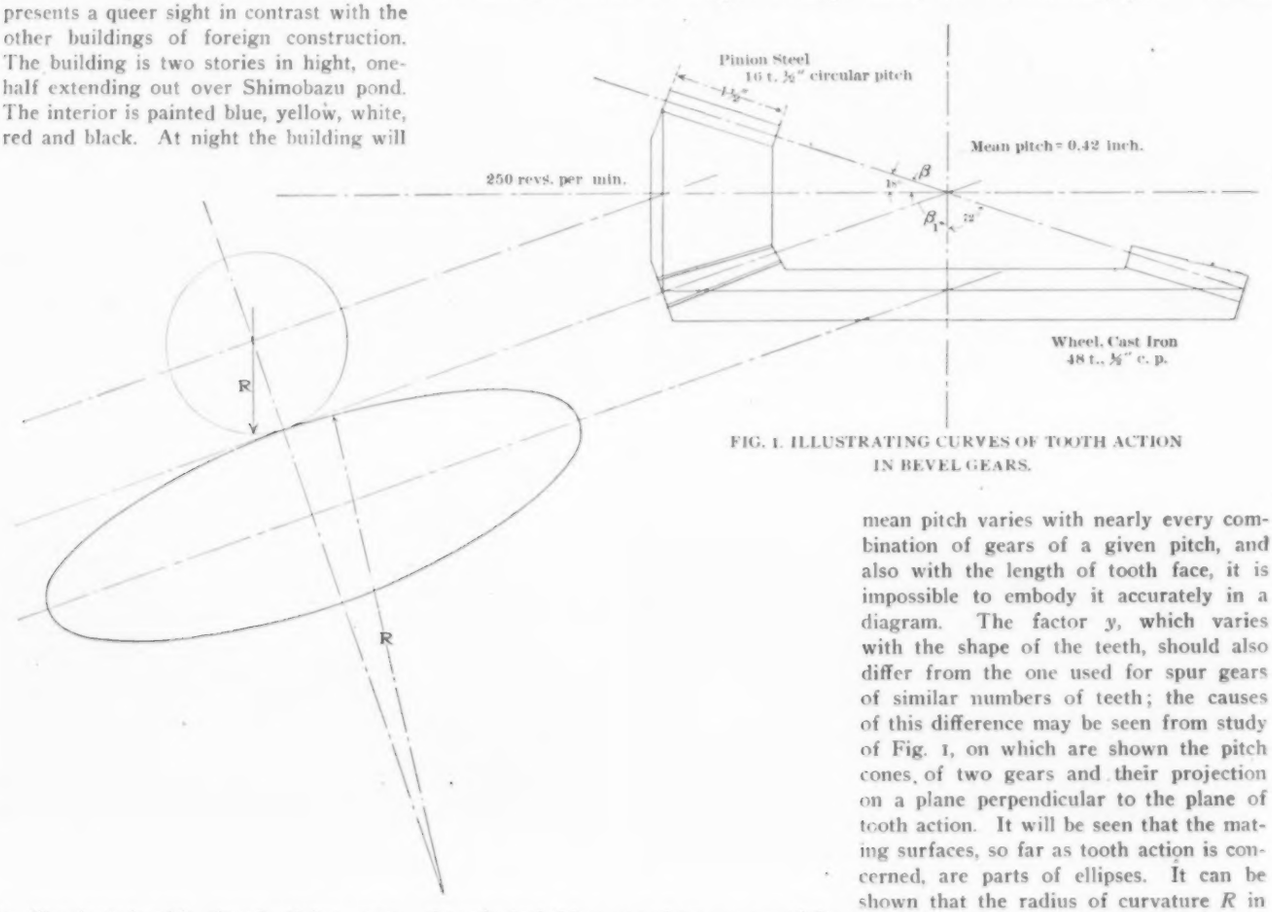


FIG. 1. ILLUSTRATING CURVES OF TOOTH ACTION IN BEVEL GEARS.

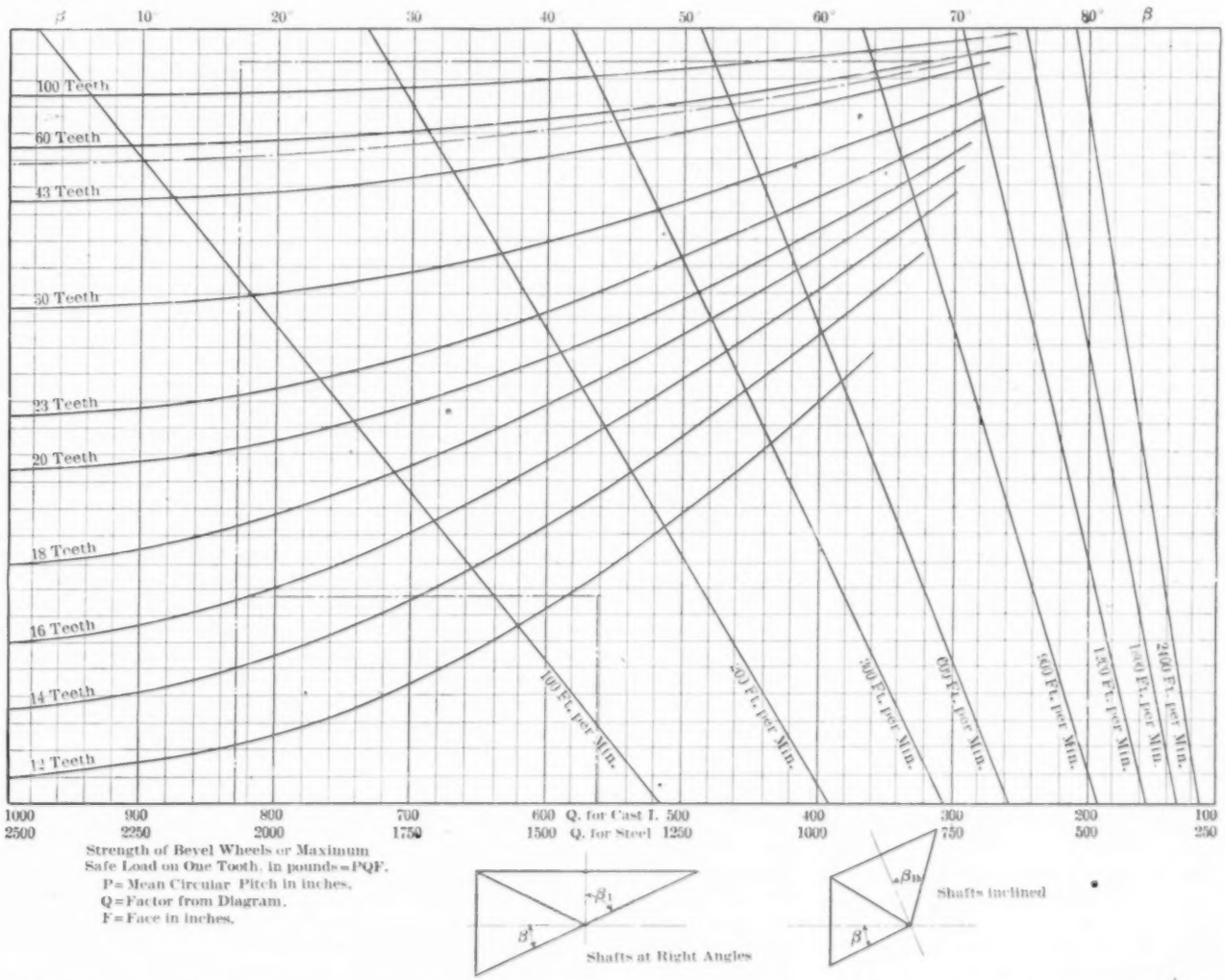
Example of the Use of the Diagram

Example: To find the strength of the wheels shown in Fig. 1, in which the max-

*The demonstration of this statement is given at the end of this article.

imum pitch is ½ inch, the mean pitch = 0.42 inch, and the length of face = 1½ inches; the pinion has 16 teeth and the wheel 48.

Strength of bevel gears = $P\,Q\,F$, where P = mean pitch, F = length of face; Q is a factor to be obtained from the diagram. On the diagram we run along the line for 16 teeth until opposite the angle 18 degrees and then horizontally to a point between 100 and 200 feet per minute peripheral speed, as shown by the horizontal and vertical lines, reading the factor Q for steel on the base. The readings for the wheel are also shown on the diagram.



Strength of Bevel Wheels or Maximum Safe Load on One Tooth, in pounds = PQF.
P = Mean Circular Pitch in inches.
Q = Factor from Diagram.
F = Face in inches.

Shafts at Right Angles

Shafts inclined

Maximum load for pinion = 0.42 × 1400 × 1½ = 882 pounds.

Maximum load for wheel = 0.42 × 830 × 1½ = 523 pounds.

Another Use for the Diagram

The diagram may be useful in another way—to determine the minimum number of teeth permissible in a gear. It is practice in some places not to use pinions less than 20 teeth for important duty. The diagram shows the equivalent spur gear for any bevel of known teeth and pitch angle. For instance, by running along the line 14 teeth until opposite to $\beta = 45$ degrees, we see that a pair of miters of 14 teeth are equal, in regard to tooth action and shape, to a pair of spurs of 20 teeth.

Proof of the Radius of Curvature Proposition

The proposition employed herein, regarding the radius of curvature of an ellipse, is sometimes quite useful. It was, for instance, used by H. D. Williams, at page 259, Vol. 26 (1903), in his article on the "Measurement of Contacts." It is, perhaps, not as widely known as it deserves, so the proof will be given here for the benefit of such readers as are able to follow the mathematics:

The radius of curvature of a plane curve, as derived by calculus =

$$\rho = \frac{\left\{1 + \left(\frac{d\,y}{d\,x}\right)^2\right\}^{\frac{3}{2}}}{\frac{d^2\,y}{d\,x^2}}.$$

The equation of the ellipse is:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1;$$

$$\frac{y^2}{b^2} = 1 - \frac{x^2}{a^2} = \frac{a^2 - x^2}{a^2};$$

$$y^2 = \frac{b^2}{a^2}(a^2 - x^2);$$

extracting the square root:

$$y = \pm \frac{b}{a}\sqrt{a^2 - x^2};$$

taking the first derivative:

$$\frac{d\,y}{d\,x} = \frac{b}{a}\,\frac{x}{\sqrt{a^2 - x^2}};$$

taking the second derivative:

$$\frac{d^2\,y}{d\,x^2} = \frac{\frac{b}{a}\left\{\frac{\sqrt{a^2 - x^2}}{1} + \frac{x^2}{\sqrt{a^2 - x^2}}\right\}}{a^2 - x^2}$$

$$= \frac{b}{a}\left\{\frac{a^2}{(a^2 - x^2)^{\frac{3}{2}}}\right\} = \frac{a\,b}{(a^2 - x^2)^{\frac{3}{2}}}.$$

At the extremity of the minor axis $x = 0$ and $y = b$; substituting these values, radius of curvature at this point =

$$\rho = \frac{\left\{1 + \frac{b^2}{a^2}\,\frac{x^2}{(a^2 - x^2)}\right\}^{\frac{3}{2}}}{\frac{a\,b}{(a^2 - x^2)^{\frac{3}{2}}}} =$$

$$\frac{\left\{\frac{a^2(a^2 - x^2) + b^2 x^2}{a^2}\right\}^{\frac{3}{2}}}{\frac{a\,b}{(a^2 - x^2)^{\frac{3}{2}}}} \cdot \frac{1}{(a^2 - x^2)^{\frac{3}{2}}} =$$

$$\frac{\left(\frac{a^4}{a^2}\right)^{\frac{3}{2}}}{a\,b} = \frac{a^3}{a\,b} = \frac{a^2}{b};$$

$\therefore b : a :: a : \rho$, or, the radius of curvature is a third proportional to the semi-minor and semi-major axes, q.e.d.

Shop Practice in the Engineering Course of the University of Cincinnati

By J. M. Manly

In the American Machinist, Vol. 28, Part 2, page 540, there appeared a paper by Dean Herman Schneider, of the University of Cincinnati, outlining a proposed course in engineering which would give practical work in the shops of the city in conjunction with instruction in the engineering college of the University of Cincinnati. The plan has been modified to meet industrial conditions and, as prophesied in the editorial of the American Machinist at that time, is meeting with success.

The new arrangement is called the Co-operative Course in Engineering and contemplates that a student shall work alternate weeks in the shops of Cincinnati and in the engineering department of the university. The students are divided into two sections which alternate with each other, so that one section is at the university while the other is at the shops; in this way the shops are always full-manned. The course applies to the departments of mechanical, electrical, and chemical engineering, and covers a period of six instead of four years, leading to the degrees of mechanical engineer, electrical engineer, and chemical engineer, as the case may be. It must be understood that the university work is the same as that of the regular four-year course; in fact it has been amplified to a considerable extent because of the work which the students do in the shops; that is to say, broader courses in economics, shop organization, shop accounting, business law, patent law, and other subjects which will widen the horizon of the student and give him the theory underlying his shop experience have been added. Some of these lectures are given at night and in many cases are by business men who are experts in their particular lines.

The object of this course is to make a competent, practical, and well-rounded engineer. It is believed that certain men are temperamentally suited to the various lines of engineering and consequently the proposition of selecting the raw material has been thoroughly considered. It is not believed that the problem of higher technical education is to make so called pure engineers as much as it is to make engineers for commercial production; for investigation discloses the fact that a very small proportion of engineers become pure engineers, and a great majority become concerned in actual manufacturing. Consequently it seems absurd to withdraw a young man for four years from all contact with commercial life in order to prepare him for commercial life. Furthermore, the methods employed in the average university shops may be classified as advanced kindergarten work, and it is held by many manufacturers that students receive no shop training in colleges worthy of consideration in actual commercial production. In the coöperative course the men receive their practical training under actual shop conditions in a course so planned that they follow the path of the article manufactured from the raw material to the finished product. In some cases, for instance, the young men begin in the foundry and finish in the sales office, and during the intermediate time they are engaged in the various successive stages of work necessary to produce the finished product of that particular factory. A system of transference to various shops is now being arranged in order that every student may obtain the broadest possible experience.

Students who desire to take this course are required to enter the shops in June preceding the opening of college; that is to say, all the young men of next year's class will be required to enter in June, and will be accepted at the university in September, only upon the recommendations of their employers. It will be observed that this is a weeding-out process which has been aptly termed "the elimination of the mollycoddle." It is evident that the young man who is afraid of dirt and hard work will surrender to his mental cowardice in this matter as soon as he learns what the course means to him, so that a large number of young men who think they want to become mechanical, electrical, or chemical engineers but who desire to work along the lines of least resistance, and are not desirable men for these professions, are eliminated at the very beginning by their own mental processes. Of those who take up the work in June a small number quit during the summer, and when September comes there is a residue left which can be depended upon for results. It may be stated parenthetically that this system permits the university to operate its engineering college at the highest efficiency; for being given a certain sum of money with which to train a certain number of men, they are training only those men who by mental, physical and temperamental adaptability are worthy of the expenditure which the college makes.

The course is working very smoothly and with such satisfaction to the shop owners that they have made a voluntary increase in wages; the new scale begins at 10 cents per hour and is increased one cent an hour every six months, so that in the last half of his sixth year the student is receiving 21 cents an hour. The manufacturers have found that the young men obtained through this course all add intelligence to their work, and that as a rule they produce more, as shown by actual time cards, than the regular apprentice. They also say that the two men of the pair working alternating weeks operate like one man, and that there is no confusion when the new man takes up his work on Monday morning. Next year, in order to avoid all possible friction at this point, the young man who is at the university will go to the shop on Saturday and receive instructions from his alternate as to what he has been doing on his machine, and how it has been done.

It is probable that the majority of these young men will become supervisory officers or employers some day, and they are now enjoying an opportunity, which many college men do not have, of being in close contact with all sorts and conditions of labor during their work in the shops. It is the opinion of the university authorities, and of the manufacturers also, that the young men of this course will learn much more about labor problems by association with the different classes of laboring men in the shops than could be taught them by a long course of lectures. It is intended, however, to supplement the knowledge obtained in the shops by a thorough course of lectures on labor problems.

The university authorities state that the coöperative students are under the same instructors at the university as their four-year students, and that it has been found that the half-time students do about 20 per cent. more work a week than the four-year men and need no urging to forge ahead; they are the most satisfactory students the university has ever had. It should be noted in this connection that since the coöperative student works nearly four full months during the summer and half-time during the eight months of the college year, during one year he works a full period of eight months; in six years he works a period of forty-eight months, which is equivalent to four years; so that in the six-year coöperative course the student gets four years of practical work and the equivalent of the usual four-year college course.

It is a matter of great gratification to the manufacturing interests of Cincinnati that this course has met with the success which was hoped for it, for it gives the manufacturers young men earnest in purpose, willing to do hard work and eager to learn, and puts in the hands of the employer a great portion of their actual training in shop work, supplemented by the thorough scientific training which will be given at the University of Cincinnati; the manufacturers will have college graduates who are skilled in the actual methods of production and who have been broadly trained in the many phases of manufacturing; it will enable the employer to become familiar with the special capabilities of his student apprentices and to so train them that they will

fit into his organization to the best possible advantage.

That this course appeals to the right kind of American youth is evidenced by the fact that applications for next year's class have already reached such a number that the electrical-engineering positions are all filled, and that a number of young men have already signified their intentions of entering in June, 1908; in chemical engineering there are about twelve positions still open; in mechanical engineering about thirty—for, since the shops of Cincinnati are largely mechanical, there are, of course, a great many more places open for mechanical engineers than for electrical engineers. Over one hundred applications were received prior to May 1, but some of the applicants withdrew when they learned that it would be necessary for them to take up all phases of manufacturing from the foundry on.

The university has found it necessary to set aside a special building for this work, and the successful operation of the course has modified the university's plans to the extent that the commercial shops of the city will become the shops of the university, and the major portion of the funds of the engineering college, aside from those for instruction, will be put into engineering and testing laboratories for investigation and exemplification of the various problems of industrial science. There is probably no similar condition existing in the United States so favorable to the advancement of scientific industry as exists today in Cincinnati by reason of this plan; for the coöperation between the manufacturing interests of the city and the scientific interests of the university, under the arrangement which now exists and which will be further exemplified, brings the two into a very close harmony.

New Lubricant from China

One of the principal exports of Manchuria is bean oil, whose use at the present time is largely for illuminating and cooking purposes. The manager of the Mitsui Bussan Kaisha, at Tieling, however, believes that by combining it with a small percentage of some other oil it will be possible to produce a very satisfactory and cheap lubricant, and states that his company is at present performing experiments to that end.

According to a recent Census Bureau bulletin, the total value of the metal-working machinery manufactured in the United States during 1906 was $32,408,766, an increase of $7,670,862, or 31 per cent. over the value of the product for 1900. By "metal working machinery" is meant power-operated machinery for the working of metals, including the parts and small tools required for the operation of the same. Machines and tools used in hand trades are not included.

Shop Management *

By William W. Bird

The reported remark of the fond father that he would rather have his son the manager of the college baseball team than to have him graduate at the head of his class, has a deep significance as a criticism of modern education. The business world demands that the graduate should know something in regard to commercial affairs. The leaders in education condemn commercialism and claim that it should have no part in the curriculum. This latter course is no doubt the right one for academic work, but not for a professional school. However much we may desire to condemn this spirit of commercialism, it is one of the great forces at work in the world at the present time and must be considered sooner or later by all who have a part in the life of today. We place our lives in the hands of the locomotive engineer to whose judgment is left the question of what risks to take in order to keep the train on time, while we insure our lives in a company which pays

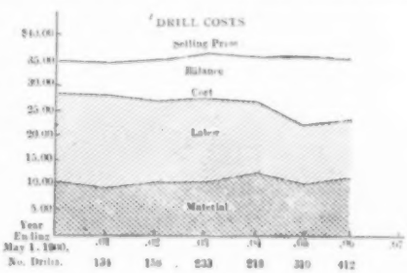


FIG. 1. DRILL-COST DIAGRAM

its president for his judgment in handling money one hundred times as much as the locomotive engineer receives. We send our children to school to be taught the essential things of life, and pay the teacher less than we do the janitor in the bank where we deposit our money for safe keeping, while those who really have charge of that money receive a princely income compared with that of the teacher. We receive spiritual advice and guidance for the life everlasting at the hands of our minister, and do not pay him one-thousandth part of what we give to our modern financier for the exploitation of our stocks and bonds. We are therefore all guilty of the modern crime and until public sentiment is changed, we might as well acknowledge the fact that it is worth while to know something about commercial affairs. Can this work be successfully taught in our schools?

The Worcester Polytechnic Institute was one of the first educational institutions to introduce shop practice and to give it a place in the regular school work. This was followed by the engineering laboratory work, the class room for theory, the laboratory for demonstration; and the same system is now being carried out with regard to shop management—lectures and recitations on business methods for theory, and the business laboratory for the real thing. And what is a business laboratory? In our case it is the Washburn Shops, which are conducted as a commercial enterprise by the department of mechanical engineering. A great many people are under the impression that the students do all the work in the Washburn Shops, and few realize that the regular pay rolls are over $900 a week, and that the drill presses and drill grinders

*From the *Journal* of the Worcester Polytechnic Institute.

SHOP PAY ROLL
For week ending March 9, 1907.

Chk. No.	Hours	Pay	Account	Amount
1	55	$ 11.00	Drills	$ 91.86
2	51	12.75	Drill grinders	140.50
4	55	12.37	Grinders	5.10
5	55	13.75	Mach. tools & rep.	9.45
6	54½	13.62	Manufacturing	14.64
7	55	13.75	Expense	0.22
8	55	16.50	Instruction	9.30
11	55	17.60	Patterns	2.98
15	55	13.75	Building repairs	0.82
16	55	11.00	.....	.....
17	55	20.00	.....	.....
18	55	5.50	.....	.....
19	55	15.12	.....	.....
21	65	5.50	.....	.....
25	47	9.40	.....	.....
26	55	11.00	.....	.....
27	56	12.60	.....	.....
28	56	15.12	.....	.....
30	55	15.12	.....	.....
33	55	5.50	.....	.....
34	57	15.67	.....	.....
37	55	8.25	.....	.....
		$274.87		$ 274.87

R. C. Williams.
J. M. Houghton.
P. M. Ferguson.

TABLE 1. A PAY ROLL

SHOP AUDITING.
February, 1907.

Foundry		$ 1,231.19
Drill grinders		117.37
Upright drills		16.47
Instruction		31.80
Merchandise		260.18
Manufacturing		16.06
Repairs		31.60
Expense		85.09
Equipment		717.43
Drawing stands		13.53
Foundry repairs		6.84
Petty cash		23.15
Teaming		5.40
Advertising		2.46
Flasks		1.35
Total expense		$ 2,559.92
Contra account		36.68
Net expense		$ 2,523.24
Pay roll		3,576.21
Total to be drawn from treasury		$ 6,099.45
Discounts and credits		32.31
Total decrease in assets		$ 6,131.76
Total sales		5,398.49
Net decrease in assets		$ 733.27
Drawn from treasury		$ 6,193.58
Collections		5,648.67
Decrease in assets		$ 544.91
Cash on hand Feb. 1, 1907	$ 3,584.15	
Cash on hand Mar. 1, 1907	3,033.50	
Decrease in assets		490.65
Total decrease in assets		$ 1,035.56
Increase in bills receivable	$ 170.69	
Decrease in bills payable	131.60	
Increase in assets		302.29
Net decrease in assets		$ 733.27

Wm. L. McGrath.
W. H. Jenks.
A. G. Belden.

TABLE 2. AN AUDITING REPORT

manufactured here are known all over the world by the machine-tool trade. The foundry is also carried on in the same way, and besides supplying castings for the shop departments, outside work is also done, and by this means a greater variety of work is secured, which means better chance for observation on the part of the student.

In the last half of the senior year students taking the course in mechanical engineering are given an opportunity to learn just how the shops are carried on at the office end. The director of the Washburn Shops has direct charge of this work and full authority to open all books and accounts for the students' benefit as he may think best. The students are divided into groups of three or four, and each week are given some special work to look up, and to make the subject of a written report. For example, the students were given the actual time cards, as turned in by the journeymen in the machine department, and required to make up the payroll, as shown in Table 1, which is a copy of their report. Table 2 is a report on the shop auditing, a system by which the treasurer of the institute keeps in touch with the Washburn Shops through the shop committee of the trustees. Table 3 is a report on drill costs for 1905-1906, and Fig. 1 is a combination of these drill reports, showing how labor costs have been reduced. Another exercise is the determination of the shop burden, and finding out how much of the balance, as shown in Fig. 1, is real profit. In the same way, the foundry burden is worked out, and a price determined for castings. The matter of shipping goods is taken up and Table 4 is a report on this work. The purchase of equipment is taken up, and the students carry on the necessary correspondence. All of this work brings them in direct contact with the regular book analysis of the ledger accounts. A report on the cost of a given machine requires a search through the invoice book and time cards for details, offering at the same time opportunity to see how goods are billed, and the prevailing prices of the materials purchased.

The Worcester Polytechnic Institute is the only engineering school at the present which can offer a course in what we have called a business laboratory, an opportunity to have real experience, and at the same time the privilege of asking questions of an instructor. The shops must be successfully managed if shop management is to be taught; the more success the shops have, the better it is for the student; the more profit there is from the regular work, the more we have for improvements and new equipment.

The institute has long had the reputation of having excellent shops, as compared with other schools of engineering, but at the same time it has suffered from the reports that students were made to do all the work, and that profits were made in this way. This criticism, whether or not true in the past, is absolutely false now. If the shops are run for the full benefit of the students, there can be no profit in their work. Profit comes from efficiency, and in order to give the student the most possible in the time spent in the shops, he must be advanced as soon as he reaches the point of efficiency. Profits and an engineering shop course cannot go together.

We have, then, these conclusions: The shops are run for educational purposes; the students are advanced as rapidly as possible in their actual shop practice; there is no profit to the shops from their work; the shops are run to make money on the work of the journeymen, for the opportunity thus afforded for real study in shop management.

SENSITIVE-DRILL COST FROM LEDGER ACCOUNT.
May 1, 1905, to May 1, 1906.

		%
Total number drills sold....	412	
Total receipts from drills..	$14,734.07	
Average selling price per drill.....	35.76	
Average labor cost per drill,	11.70	32.75
Average material cost per drill.....	12.03	33.70
Total average cost per drill.	23.73	
Average profit.....	12.03	33.70
Castings bought from foundry, 116,468 lb. @ 3½ c.	4,076.37	

JARVIS WILLIAMS, JR. ROBT. D. CENTER. A. BRADLEY BURGESS.

TABLE 3. REPORT ON DRILL COSTS

ORDERS AND SHIPMENTS.

A. Receipt of order.
  I. Classify as to
    1. Future shipment.
      a. File away.
    2. Immediate shipment.
      a. Make out dept. order.

B. Dept. order.
  I. Domestic.
    1. Name and address of buyer
    2. Their order number.
    3. Description of order.
    4. Shipping directions.
    5. Our order number.
    6. Make duplicate if for more than one dept.
  II. Export. In addition to above, note
    1 Consignee—name and place.
    2. Weights.
      a. Net.
      b. Gross.
    3. Cubical contents.
  III. Acknowledgment of order.
    1. By postal.
      Note a. Date of shipment.
        b. Their order number.
  IV. Send order to shop foreman.

C. Shipments.
  I. Three duplicate forms of blank, including:
    1. Shipping order. These include
      a. Delivered to R. R.
    2. Freight receipt.
      a. Signed by R. R.
      b. Send to buyer.
    3. Unsigned form.
      a. Stub in book.
      a. Date.
      b. Consignee.
      c. Destination.
      d. Route.
      e. Description of article.
        1. How packed.
          a. Boxed, Skidded, or Crated.
        b. Weight.
      f. How marked.

D. Entry in books.
  1. Make price on original order.
  2. Enter in day-book.

E. Send bill and shipping receipt to buyer.

HALFORD W. PARK. H. W. SMITH. C. E. THOMPSON.

TABLE 4. REPORT ON ORDERS AND SHIPMENTS

The Canadian Locomotive Works, at the Kingston district of Canada, are adding a workshop to their plant at a cost of $150,000. The output of four locomotives per month will be increased. American-made tools and machinery are largely used in these works.

A Time and Cost Computer for the Boring Mill

By William Cox

The value of the slide rule as a time saver in mathematical calculations is unquestioned, but its general use is open, as a rule, only to those whose mathematical training has been carried far beyond the posibilities open to the average mechanic.

The fact that it is almost unlimited in its capacity, and that its use entails the memorizing of an untold number of formulas, creates in the mind of the uninitiated a feeling of awe which is difficult to dissipate and which still further curtails its usefulness.

I have given considerable attention to the application of the logarithmic principle of the slide rule for the solution of special problems and have recently designed for the Bullard Machine Tool Company, of Bridgeport, Conn., a "Time and Cost Computer" for determining those elements of boring- and turning-mill work.

This instrument is, in reality, a circular slide rule in which the various scales —six in number—have been given special values corresponding to the elements which enter into the required calculation.

The formula which it solves:

$$T = 0.2618 \times \left(\frac{D \times L \times F}{S} \right)$$

is derived as follows:

$$T = \frac{L \times F}{R},$$

in which

$$R = \frac{S \times 12}{\pi \times D},$$

which resolves into:

$$T = \frac{\frac{L \times F}{S \times 12}}{\frac{\pi \times D}{}} = \frac{\pi}{12} \times \frac{D \times L \times F}{S}$$

$$= 0.2618 \times \left(\frac{D \times L \times F}{S} \right),$$

in which

T = time required in minutes,
D = diameter of piece in inches,
L = length of cut in inches,
F = rate of feed per revolution in parts of 1 inch,
R = revolutions of piece per minute,
S = cutting speed in feet per minute.

The usefulness and time-saving qualities of this instrument, compared with the usual pad and pencil method, are well illustrated in the following example (a cast-iron cylinder is assumed):

Cutting speed, 35 feet per minute, A; feed per revolution, ⅛ inch, B; diameter of piece, 20 inches, C; length of cut, 30 inches, D; time required, 36 minutes, E. The accompanying cut shows the scales set in the required position for the solution of this problem.

Another scale, not shown, determines the cost per operation at any hourly rate from 1 cent to 60 cents. The determina-

tion of the proper feeds and speeds to be used for the completion of a certain operation in a given time is another valuable feature. The directions for operation which accompany the computer are clear, concise and permit of a ready understanding of the use to which the instrument may be put.

DIRECTIONS

(a) To find time required for turning or boring:

1. Set the given cutting speed on the sector opposite the given feed on the bottom scale of computer.

2. Hold sector in this position and bring known diameter on disk opposite arrow on sector.

3. Opposite any given length of piece on top scale of disk find, on top scale of computer, the time required for such given length.

(b) To find approximate time required for facing:

Diameter will be one-half the sum of "inside" and "outside" diameters of surface to be faced.

Length of cut will be one-half the difference between "inside" and "outside" diameters.

Cutting speed should be considered as a constant at "diameter" deduced.

Having determined the above factors, proceed as in application *(a)*, a cylinder being assumed.

(c) To find suitable cutting speed and feed, when dimensions of piece are known and time required has been fixed:

1. Set known length of piece opposite time allowed.

2. Hold disk in this position and bring arrow on sector to known diameter.

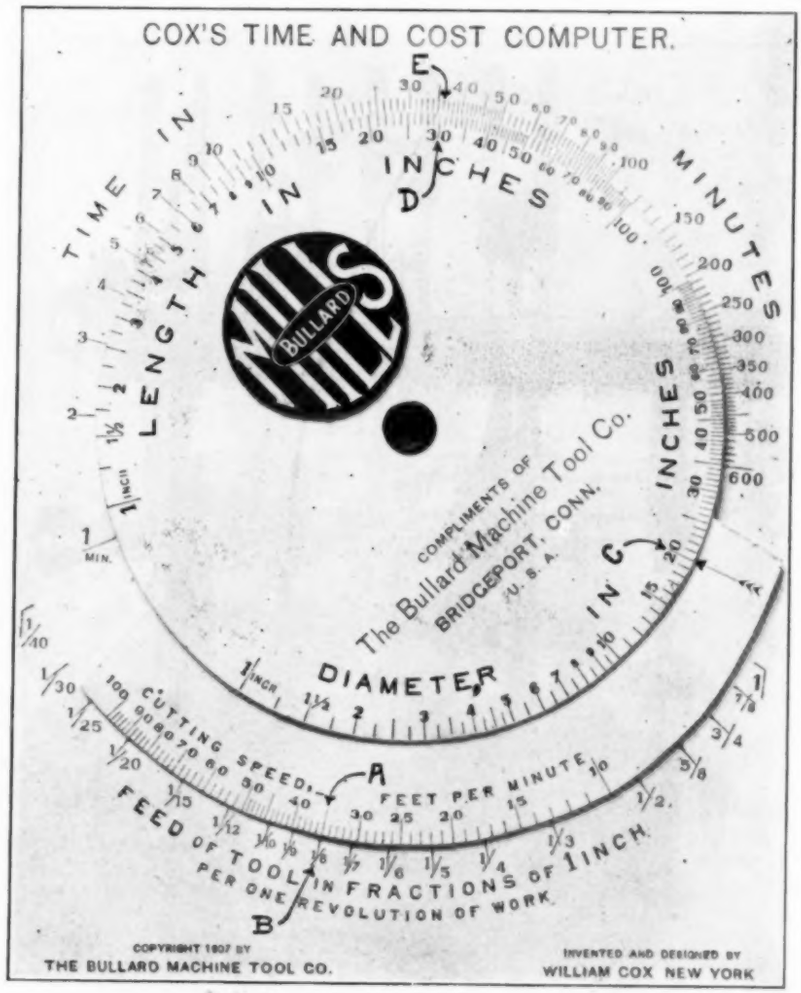
3. All coinciding lines of cutting speed and feed will give the desired result. Selection may be made according to prevailing conditions.

(d) To find cost when time is known:

1. Set rate per hour (on small sector scale) to time in minutes.

2. Opposite arrow marked cost find (on time in minutes scale) the cost in cents.

Note—If feed per revolution is less than 1/40 inch, multiply given feed by 10 and use product in making calculations. Resultant time should be divided by 10 to secure correct solution.



A TIME AND COST COMPUTER

Echoes from the Oil Country—Fool-proof Gages

BY W. OSBORNE

At page 711 is expressed a desire for fool-proof gages. That same desire has been expressed by many of us many, many times, and in connection with numerous other things beside gages. There are many sides to the gage question, and the side that does not always get the attention it should is the side of the men who have to use the gages in getting out work.

When mention is made of fool-proof gages, most of us will have visions of the chap who uses a gage as a hammer, or who takes a hammer to help get it over the piece that he is at work on, or of the one who gets it caught on a revolving shaft and tries to get it off without stopping the lathe, or of the one who lays it down on the shears and lets the carriage run up against it; but we may also have visions of the gages that were bought so long ago that no one remembers when it was, and which have been used so long that no one knows what the real sizes are, although the "nominal" sizes are stamped on them. We may know, by having learned by bitter experience, that we must bore our pulleys by one 3-inch gage and turn our shafts by another if we wish them to fit, and we may even have had experience enough to know about how much looser than either to turn the piece that is to fit some other shop's 3-inch piece.

From this it can be seen that while the management may be looking for one kind of a fool-proof gage the workman may be just as earnestly looking and longing for another, but just as necessary, kind.

I think there is just one condition that is worse than trying to run a shop without gages, and that is trying to run it with gages without keeping them to size.

OIL-COUNTRY PRACTICE

In one oil-country shop the gage question does not give very much trouble. Most of the working gages are home-made, being forged from scraps by the blacksmith. After being filed closely to size they are hardened on the points and then gone over with a fine emery slip. Brown & Sharpe reference disks and end measuring rods furnish sizes to make and keep them to, and these never go out into the shop for any purpose. The important gages are tested for size once a week, and oftener if for any reason it is thought necessary. If a man gets a gage caught on work, and thinks that he may have sprung it, he takes it to the foreman, who has it tested. If it is found to be wrong, it is brought to size again and returned to the man.

As these gages are cheap there is no hesitation about making one whenever it is needed, and so there are plenty of them

and it can always be told with reasonable certainty who damaged a gage if it is damaged and not reported. The men understand that it is considered much worse not to report damage than it is to do the damaging, and most of the gages turned in under suspicion are not off size.

Testing and Correcting Gages

For the regular test the gages are brought in and left over night in the room with the test pieces, so that there may be no question about differences of temperature. They are all made so that they give a "feel" on the standards. In case they are off size (the professional gage-maker and the fine-tool maker, and the man who thinks and works in fractions of ten-thousandths of an inch will please either skip what follows or else remember that too much perfection might not harmonize with all parts of an imperfect world) they will, of course, be either too large or too small; the remedy is the same in either case. *Peen them.* Don't draw in your breath and grit your teeth. It is not nearly as barbarous as it sounds. Take a smooth plate and a light hammer with a rounding face, and mind that you are working on a fine gage. See that the place which you need to hit is being supported by the plate on the other side—*exactly* on the other side, not near to it. If the gage is too big, the peening should be on the flat side close to the outer edge, and about midway around from the ends; and *go easy*, for a very little touch will move the points in. If the gage is badly out it may be as well to do some of the work on each side. If the gage is too small it will be necessary to peen on the inner edge of the forging. It is to be understood that this peening is done on the flat sides of the gages, and not on the thin edges. Theoretically it would seem that it would be better to do it on the edges, but when the amount to be corrected is only a "feel," and it is understood that there are several "feels" for the ordinary machinist in a quarter of a thousandth even if he does not think or talk that fine, it will be seen that the amount to be moved is very small, and the work can be done much more accurately by laying the gage down flat and striking it on the broad side.

As it is the work of a few seconds to correct a gage for ordinary work, it is not much trouble to keep all of them in order, for it is only occasionally that one is found to be out. It may be that the fact of the tests being regularly made has some influence in making the men more careful with them.

If a new gage has to be made for an important size, and put to work at once, it should be watched closely, for it may be found that it will alter considerably in size before it gets finally seasoned.

By watching the jaws of the gages it will sometimes be seen that the bearing is all on one point; in that case the hard spot can be eased off, but ordinarily it is not necessary to do any dressing after the peening.

Reference Disks

It may be that there are some shops where it is thought that the expense of the reference disks prohibits the use of this method. If it is only desired to make the work interchange with itself and not with the outside world, gages can be made to the sizes already in use and disks turned up to them. A soft cast-iron disk that is used only as a reference disk, will last a lifetime if kept free from rust. If large micrometers are at hand, disks can be turned to them, and then the gages made and kept to the disks with the assurance that the sizes are commercially correct.

There is one consideration that should have weight. It has been found that there have been times when the accuracy of the standards has been disputed by customers. In such cases the ability to demonstrate that the basic size has on it the firm name of a concern known all over the world for accuracy counts for much.

I do not know whether the friend who signs himself Gage is having his troubles for need of fool-proof gages as machinist, toolmaker, inspector or manager, but I hope that in any case this may, at least, not increase his burdens.

A Bolt-turning Machine

By E. A. Dixie

In a shop I visited recently there was a machine which turned bolts, with both straight and taper bodies, true to gage and at a speed that I have never before seen equaled. This machine was designed by Samuel M. Vauclain, superintendent of the Baldwin Locomotive Works, for rapid finishing of straight and taper bolts.

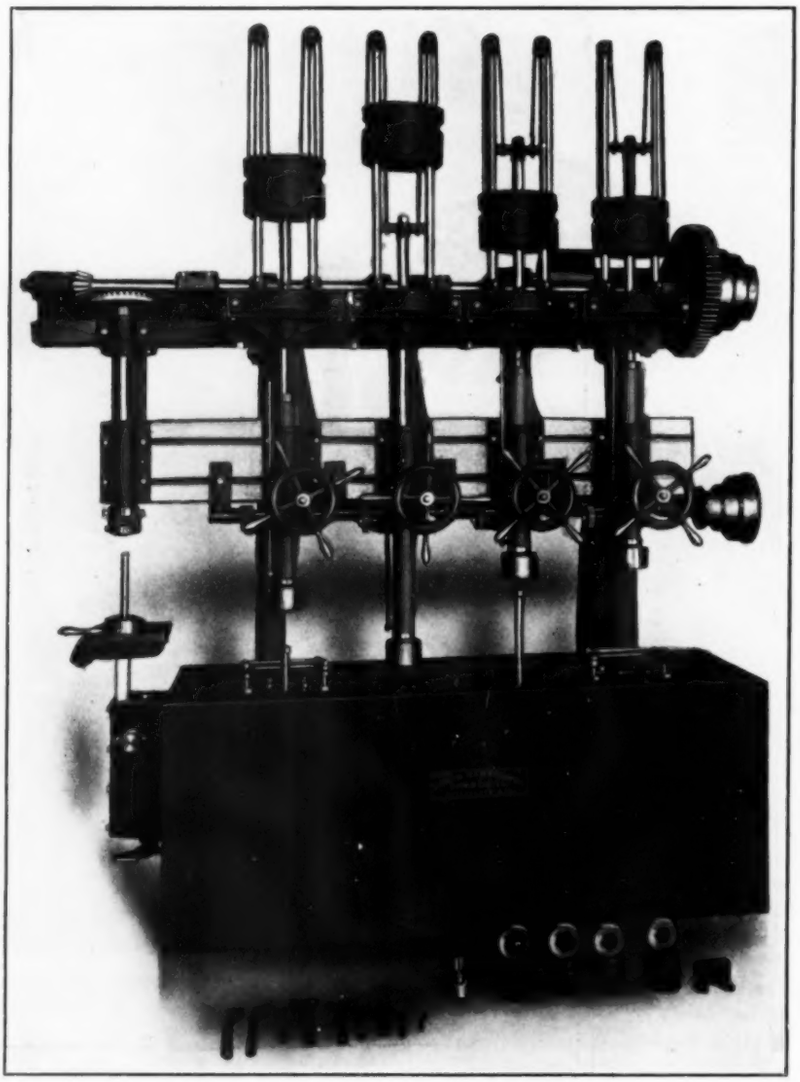


FIG. I. THE BOLT-TURNING MACHINE

Fig. 1 shows the machine arranged with five spindles, two of which are for roughing and two for finishing cuts, while the fifth spindle shown at the left-hand side

is for pointing the ends of the rough blanks before putting them in the machine. Where the amount of work requires the use of more than one machine, this feature is generally omitted, and the pointing is done on a separate machine.

The cutting tools are mounted in exact alinement with the spindles, in a tank bolted to the frame of the machine and

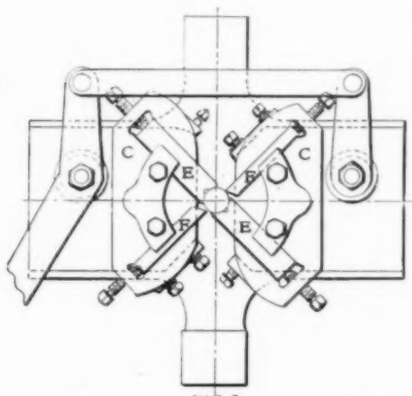


FIG. 2

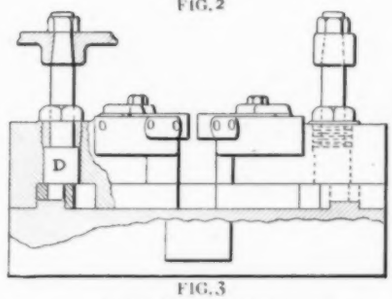


FIG. 3
THE ROUGHING DIE

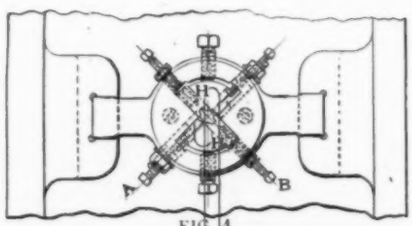


FIG. 4

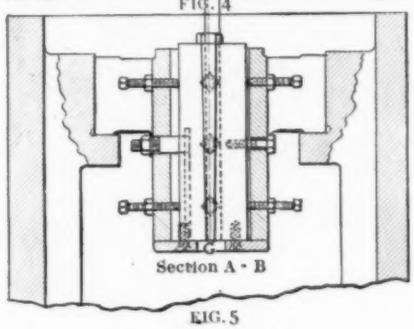


FIG. 5
THE FINISHING DIE

filled with oil, while driving chucks suited to the heads of the bolts are mounted on the spindles.

The roughing cutter heads are shown in Figs. 2 and 3. They consist of two slides *C C*, actuated by eccentrics *D*, which are connected together to a hand lever. In each of these slides are mounted a guide *E* and a cutting tool *F*, which are adjustable to suit the different sizes of bolts. These roughing heads are for straight turning only; where the machine is used for finishing straight bolts, it is fitted with four of these heads, two of which are adjusted for finished size.

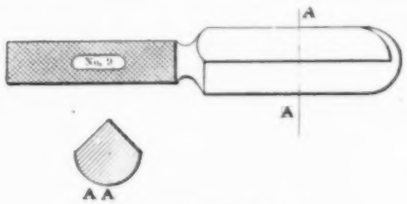
The taper finishing heads are shown in plan and section in Figs. 4 and 5. These have the same arrangement of guides and cutting blades as the roughing heads, except that they are not made quick opening.

The guides and cutters are adjusted to size by means of a standard plug which is fitted in the center hole *G* in the bottom of the head, and are securely clamped in place by the blocks shown at *H* in Fig. 4.

A Hardness Standard for Hardened and Tempered Work

By A. L. Pratt

Mr. Ballentine's article on page 698, describing an instrument for testing the hardness of metals and other materials, is of interest to me, for I have had considerable to do with the testing of hardness. The instrument referred to is, I believe,



A HARDNESS-TEST PLUG

a real step forward; yet I question if it is applicable to the broad field of hardening and tempered work, and perhaps its inventor did not intend that it should be.

Some work would be too delicate in its character to permit the use of the sliding hammer of this instrument, because of the danger of breakage; other work would be of such a shape as to preclude its use. Still again, in an inspection room handling many thousands of pieces each day, the time consumed in the test and the expense of the recording disk would be sufficient to render it impracticable.

There is probably no place, however, in the machine shop where a standard of some kind is needed to the extent to which it is needed in the hardening room. All other manufacturing departments have a system of gages and standards, but the average hardening department has nothing. How many of us have seen an attempt made by some old-time hardeners to throw an air of mystery around their work. The methods which they used stopped at times only a little short of incantations; one man would have a small box of some powder absolutely necessary as an ingredient of the plunging bath; this powder might be salt, or borax, or some equally harmless substance; another would jealously guard a vial containing a liquid warranted to bring success, which might be acidulated water, or just plain water, or something equally as simple. Yet these men should not be condemned as fakers, for many of them believe that the particular methods which they use are absolutely necessary to success. It is possible that these conditions may have been fostered by tales of medieval sword-tempering, yet in reality it is the hight of absurdity. The hardening and tempering of steel obey rigid fixed laws, although these laws are none too well known and recognized.

True, the personal equation of the individual enters into the work to a great degree. The temperature of plunging must be right for a given grade of steel to produce satisfactory hardened work, and this is a matter of keen judgment. I once had an opportunity to check the work of a very successful hardener with interesting results. His furnace was connected with a Le Chatelier pyrometer. He had no means of knowing the indication of the instrument, although he knew that the instrument was connected with his furnace. For a series of pieces of the same kind he would often plunge, individually, a lot of 25 or more, and the variation of furnace temperature would not be over an average of 5 degrees Centigrade and a maximum variation of not over 10 degrees. His judgment of relative temperatures was very accurate indeed. It is needless to carry this thought further, for all of us who have had the responsibility of a hardening department appreciate what a factor the individual judgment of the man is in successful production.

Let us consider the usual methods of testing and inspecting such work. The universal tests are the color and file tests. At times on large and heavy work a hammer is used, but the average machine-shop test is with a file.

Now this file may be a good American or a poor Swiss. It may be new or old. It may be coarse or fine, and it may be sharp or dull. In its use the personal equation enters again to a degree. The inspector may use it with vigor of muscle and keenness of nerve following a good night's rest and an excellent breakfast, or his nerve may be shaken by a night "up with the baby" or "up with the boys." In any event, if his instructions call for a hardness by name, as *very hard, soft* and *spring temper*, or if the call is for a temper color, as *dark straw* or *blue*, or if the call is for a certain number of degrees of temperature for the drawing bath, he is comparing a sensation given him by the action of the file on the work with an impression somewhere in his brain of how the file ought to act on the

particular piece. This standard is rather intangible as a shop asset.

I once knew an inspector who was very successful in handling hardened and tempered work. He had collected a number of samples of the various parts which passed frequently across his bench, and he used these samples in testing each similar lot as it came along. His method was direct comparison with a file. Having in mind his method, appreciating the conditions which have been noted above and believing what was needed was a definite standard for comparison in hardened and tempered work, I at one time made a set of what I termed *standard hardness test plugs*. These were made and used experimentally, and I regret that no data are yet available for their use on a large scale; yet the principle may be of value to someone.

Ten plugs formed a set numbered from 0 to 9 inclusive. The acompanying illustration shows the shape. As made, each plug presented a flat, a cylindrical, a spherical and a concave surface, a 90-degree corner and corners at the meeting of a flat with a cylindrical, a spherical and a concave surface, respectively. These would cover in a general way the various conditions met with in ordinary work.

The plugs were made from a high-carbon tool steel of a known analysis. The best temperature of plunging was determined by experiment with small test pieces; all plugs were plunged at the temperature determined upon. The temperature of the cooling bath (a saturated brine) was under control and kept uniform. One plug No. 0 of the series was left hard; the others were drawn in oil to various temperatures to form a descending scale of hardness in which No. 9 was very soft. These temperatures, which were finally determined upon for the drawing, are as follows:

Plug Number	*Temperature of Drawing Degrees Fahrenheit*
0	0
1	400
2	425
3	450
4	475
5	500
6	525
7	550
8	575
9	600

This range when tested experimentally seemed to cover the general field of hardened work. One test made with the set was to ask a man used to such testing to sort the plugs into a descending or ascending series by means of the file test. Different men gave different results, as might be expected. The relative success or failure seemed to be a measure of the man's acquaintance and experience with the file, for inspectors of hardened work invariably arranged them in a correct series.

It is intended in using this system of standards to have the drawing room supply the hardening department with information on the drawings, or otherwise, as to what temper a piece is to have, that temper being indicated by number. The test plug in the hardening room corresponding to that number is the standard of comparison to be used. It is independent of the physical condition of the file and independent of the physical condition of the man. The test consists in comparing the sensation produced by filing the piece to be tested with a similar and immediate sensation in filing the test plug with the same file.

Keeping the Line Shaft Clean

By Blue Overalls

The short description of shaft cleaners at page 601, Vol. 30, Part 1, is interesting, not because new, but because it brings to mind the picture of the busy activity of such workers. They start as soon as the machinery starts and race back and forth all day, sometimes in pairs and sometimes in opposition, doing their work most thoroughly. It also raises again in my mind the question, Why do they move back and forth? I will be told that they assume a diagonal direction across the shaft, the rotation of which carries them along. There is still a little question in my mind as to the advantage, or disadvantage, of an appreciable thickness of the disk. I believe the illustrations on page 601 show the disks entirely too thick, and also standing in a position that would not carry them along the shaft. Mr. Mougey's statement that the bore should be in proportion to the diameter of the shaft about as shown, also admits of a question. Of course we take the drawing to be diagrammatic only.

Similarity between Shaft Cleaners and Oil Rings

All this may seem idle speculation, but it is used partly as an introduction to the subject of oil rings. A certain form of oscillating oil ring is extensively used by the Westinghouse Electric and Manufacturing Company. I believe the idea was patented. It consists of reboring the ring at a slight angle from the normal bore, thus causing it to contact with the shaft at a ridge that runs diagonally across the ring. In making the complete circuit of the ring, the ridge passes from one side to the other and back to the starting point; this causes the ring to oscillate back and forth, and it is supposed to give a better distribution of the oil, also to prevent wearing a groove in the shaft.

Information on Oil Rings Wanted

We all know that oil rings of various forms have given more or less satisfaction—or dissatisfaction—at various times and places; and if anyone knows of an authoritative work on the subject of oil rings, he can do me and perhaps many others a favor by naming it in the columns of the American Machinist.

I have at different times seen unsatisfactory oil rings and will say that it has sometimes happened that the difficulty has been overcome without anyone finding out exactly what it was or what cured it. It is my belief that the quality of the oil has sometimes much to do with retarded action. It may also be urged that a large diameter of ring, giving a small area of contact on the shaft, would tend toward retarded action. My belief is, however, that this would make small difference inside of any limits that are likely to occur. If anyone has tried an exhaustive series of experiments in this line, an account of the same would be very interesting.

In observing oil rings on different makes of machinery, there is evidence that designers have attempted to reduce the side friction of the ring in the slot in which it runs by giving it a triangular section or heavily chamfering the outer corners. Some contend that a broad bearing on the shaft is a necessity, but the picture of some old wire rings flying around the shaft at a rate seemingly all out of proportion to the speed of the shaft and the driving friction would negative that idea.

About the only oil-ring experiment the writer has ever indulged in was an attempt to show how much heavier on one side than the other the ring would have to be to cause it to fail to revolve. No means were at hand to carry the experiment out accurately, but it was soon decided that no ordinary eccentricity of drawn brass tubing would ever retard a ring an appreciable amount.

A Peculiar Action of a Ring

The incentive for trying this experiment was a peculiar ring action that was attributed to an eccentric ring. This action consisted of a slight backward movement of the ring, with the shaft still running forward. To see a ring on a shaft moving at a peripheral speed of 20 feet per minute slow down, stop and turn backward about 10 degrees is enough to make one think there is something the matter with his eyes, or some organ farther in his head. Having observed action of this kind and meeting with some incredulity on relating it, I took pains to call a number of competent witnesses, some of whom are still living, and might be able to testify to the truth of this statement. Any better theory as to the cause of this action than the one that came to me, and has not been dislodged, would be acceptable. I am quite sure that it was not an optical illusion, as the ring was running too slowly to give that effect which is often noticed when a moving body slips.

If the foregoing leads to something of a discussion of oil-ring defects and weaknesses, tending toward a removal of them in general practice, its object will have been attained.

Steel and Other Material for Automobiles*

The Use and Adaptability of Special Alloy Steels and Composition Castings for Automobile Parts, Discussion of Their Characteristics

BY ELWOOD HAYNES

Since the first attempt to build automobiles, early in the 90's, experimenters have had difficulty in getting materials suitable for the purpose. Steel of high tensile strength was employed but the results were ever the same. Lower carbon steels were tried, but they lasted only a few weeks or months and then broke short off. Swedish iron did not break, but when the first hard bump was encountered it took a set and the wabbling rear wheels indicated what had happened. Finally a steel of moderately low carbon was introduced which gave only fair results, and if the car was driven for any length of time over rough roads, this also crystallized and broke off.

Nickel Steel

In 1899 a nickel-steel axle was introduced into a machine by Messrs. Haynes & Apperson, and the car made successfully a trip from Kokomo, Ind., to New York, a distance of about 1000 miles, without serious breakage of any kind. This axle was made by the Bethlehem Steel Company, of Bethlehem, Penn., and so far as is now known, was the first material of this kind ever introduced into an automobile. Nickel steel was used in the axles of cars of this construction for about five years, and not a single case of breakage occurred during that period. Not only was this steel found to be practically free from crystallization, but it possessed a very high elastic limit—about 70,000 or 80,000 pounds—and a tensile strength of over 100,000 pounds, with an elongation of about 15 or 20 per cent.

Soon afterward nickel steel was introduced into the construction of driving chains and showed great superiority over those formerly made of ordinary steel. When the sliding gears were first used on the automobile for the purpose of changing the gear ratio between the motor and rear axle, trouble again asserted itself in breakage. In vain were gears made of the best form of tool steel; the ends of the teeth would break off when an attempt was made to throw them suddenly into engagement by means of the shifting levers. Trouble of a very serious nature resulted from this as pieces of the broken teeth would get into the other gears, thus causing them to break, and sometimes the entire train of gears would be almost ground to pieces on account of the breakage first of one gear and then of another.

Nickel-chrome Steel

Machinery steel, case-hardened, was tried, and while this gave better results, it was by no means satisfactory. The injury and breakage of sliding gears were taken as a matter of course, and almost every person possessing a car equipped with these gears expected sooner or later to make a number of replacements.

It was finally discovered that an alloy consisting of iron, nickel, and chromium possessed most remarkable properties. Not only could the steel be hardened by heating to redness and quenching in oil, but it could be given a considerable amount of toughness at the same time by drawing the temper somewhat after the first hardening. If the steel was properly made and afterward properly treated it was found to be almost impossible to break one of the teeth in a 6-pitch gear by means of a heavy hammer. So successful were these gears that they rendered it possible to run an entire season sometimes without the breakage or serious injury of a single tooth. Front axles, steering knuckles, and other important parts requiring high elasticity were made of this steel in certain cars with very good results.

Alloy Tool Steel

The greatest difficulty encountered by the manufacturer was in the working of the steel, which was found to be extremely difficult. Fortunately, about the time of its early introduction a tool steel was discovered which possessed most remarkable properties. This steel consists mainly of an alloy of tungsten, chromium, and iron, with but a very small per cent. of carbon. One of the most remarkable properties of this steel is its capability of becoming very hard and tough when quenched from a glowing white heat by dipping into a bath of oil. This method of tempering would ruin ordinary tool steel, but it produces in the tungsten chromium steel a substance which is capable of cutting the hardest forms of nickel steel and nickel chromium steel with comparative ease. While this alloy tool steel is not used in the actual construction of the automobile, it is referred to because its use is essential in the turning and machining of the high-strength alloy steel.

It has been found that the manufacturing and working of nickel chrome steel requires great care, as there seems to be some tendency toward segregation when the steel is in the process of making, which gives rise to hard and soft spots in the finished metal. If an attempt is made to manufacture gears from material of this character, it will be found that some of the teeth are extremely hard while others are just about the right hardness. On the other hand, even if the steel is of uniform composition and texture throughout, it will not stand very great variation of temperature without danger of injury, since it is very sensitive to heat treatment. When properly made and properly treated, however, it is perhaps the most resistant substance yet produced so far as the resisting shocks and blows is concerned. It has been found almost impossible to break a tooth from a 6-pitch gear made from this material, even with the use of a heavy hammer. This renders it especially suitable for sliding gears which are subjected to the destructive action due to the striking of the teeth when forced into mesh while in motion.

Dimensions of Test Bars, 5.91 Inches Long and 0.59 Inch Diameter

	Normal.	Slightly hardened.	Greater degree of hardness.
Elastic limit, pounds per square inch	86,909	148,072	193,589
Tensile strength, pounds per square inch	111,943	155,326	221,325
Elongation, per cent	14.5	9.1	7.7
Contraction, per cent	64.0	55.6	46.2

The results shown in Table 1 may be taken as a test of high quality nickel chrome steel made by the Krupp Company, of Essen, Germany. It will be noted that much depends upon the treatment of steel.

It will be noted from the above tests also that under the hardening treatment the tensile strength rises rapidly, and the same may be said of the elastic limit, rising as it does from 86,909 pounds to 148,072 pounds when slightly hardened, while the tensile strength rises from 111,943 to 155,326. With a greater degree of hardness the elastic limit reaches 193,589, and the tensile strength 221,325. It will be also noted that the elongation gradually diminishes from 14.5 per cent. in the normal steel to 7.7 per cent. in the more highly hardened specimen. The contraction of area also falls from 64 per cent. in the normal to 46.2 per cent. in the highly

*Presented at the Indianapolis meeting of the American Society of Mechanical Engineers, May, 1907.

hardened steel. The contraction of area does not suffer so much as the elongation. The comparatively small loss in contraction of area is a good sign, since it indicates that the texture of the steel has been well preserved under treatment.

Plain nickel steel containing a very small per cent. of carbon is also a good safe material for automobile work. The following may be taken as an example of a mild low-carbon nickel steel:

Elastic limit, 65,146; tensile strength, 81,561; elongation, 23.9 per cent.; contraction of area, 71 per cent.

It will also be observed from this that while the elastic limit is quite low as compared with the nickel chrome steel, it is high as compared with ordinary carbon steel, and that the elongation and contraction of area are very high indeed, indicating a very safe material for almost any construction. This material not only possesses these excellent properties, but resists dynamic stress remarkably well—in fact if the dynamic stresses are not too close to the elastic limit of the steel, it will preserve its strength and quality for an indefinite time. The following tests indicate the quality of this material as compared with carbon steel:

Carbon steel, 15,000 vibrations; nickel steel, 34,000,000 vibrations (Not broken).

The former shows the carbon steel under combined torsion and vibration, and the latter nickel steel under the same test. It will be observed that whereas the carbon steel withstood only 15,000 vibrations, the nickel steel was not broken under 34,000,000 vibrations.

Vanadium Steel

Besides the steels already mentioned, there is another which is now attracting considerable attention; namely, that produced by adding a small quantity of vanadium to a nickel steel or chrome steel. Since vanadium has until recently been classed among the very rare elements, it may perhaps be in place to mention a few of its properties; it is prepared from the chloride VCl_2, which is reduced by means of a current of hydrogen gas, the chloride being heated while the reduction is taking place. Simple as this process may seem, it is one of the most difficult known to chemists, and it usually requires three or four days to prepare a fraction of an ounce of the metal by this process. Until quite recently this element and its compounds, owing to their rarity, were very expensive, but we are now assured by the American Vanadium Company that a sulphide of vanadium has been discovered in an immense quantity in the Andes mountains of South America, and that they are now prepared to furnish the metal in the form of a ferro alloy known as ferro-vanadium in any quantity desired.

This ferro vanadium contains about 20 per cent. of the latter metal and is readily incorporated with the iron or steel during the melting, either in the open-hearth or crucible process. J. Kent Smith, who has given the subject of vanadium steel much attention, advocates the open-hearth process as preferable to the crucible process for the making of this steel. This steel possesses most remarkable qualities, notwithstanding the small quantity of vanadium which it contains. One of these is the closeness with which its elastic limit approximates its tensile strength, and since the former quality is the one in which the greatest dependence is placed, this is a very desirable characteristic. The sharp contraction of area, also a characteristic of this steel which together with the silky fracture it usually presents, is also a strong indication of the splendid quality of this material. Moreover, the fracture is nearly always of this quality, even though the steel has been highly tempered.

The following are the results of some tests made on oil treated bars of the above steel: It is a rather remarkable fact that the vanadium alone or with carbon does not give much character to the iron or steel, but when a third element is introduced, such as nickel or chromium, the characteristics of the steel are changed for the better. Whether the vanadium acts as an essential element in the composition of the steel or principally as a purifier is not fully known; it has been found, however, that a certain amount of the vanadium introduced (about ¼ per cent), must remain in the steel in order to give it its characteristic properties. Vanadium, however, has a strong affinity for nitrogen as well as for oxygen, and it may be that it acts as a purifier of the steel by combining with minute quantities of nitrogen gas, which might otherwise be occluded in the steel and thus interfere with its compactness and strength.

It will readily be seen that the high elastic limit, strong contraction of area and splendid silky fracture, together with the large number of vibrations which the steel endures under dynamic stress, most strongly recommend this steel as almost ideal for many parts of the motor car. The writer has made some experiments in the forging, and found that it works well under the hammer, though it must not be allowed to become too cold or it will resist pounding to a remarkable degree. It is not readily injured under the forging hammer, provided due care be taken not to heat it too rapidly. Another valuable property of the steel is that it machines more readily than nickel chrome steel—in fact, more readily than plain nickel steel.

Bronze

The use of bronzes in the motor car must necessarily be restricted to parts requiring low rigidity, and usually also moderate strength. While it must be admitted that samples of bronzes can be made that approach closely to fairly good grades of steel in tensile strength, elastic limit, and contraction of area, it must also be remembered that the modulus of rigidity of iron and steel is about 28,000,000 pounds, for example, while that of bronze is only about 15,000,000 pounds. This means that a bar of bronze of a given size and form under given conditions will deflect nearly twice as much under the same load as a similar bar of iron or steel. In most parts of the car this feature is objectionable, since changes of alinement are likely to occur, unless the parts which are made of this material are especially well designed.

Notwithstanding the above objection the readiness with which bronze lends itself to the production of castings of various parts, and its freedom from crystallization under dynamic stress has led to its introduction into many of the minor parts of the motor car, such as small hand levers, carbureters, tubing, crank cases, gear cases, etc. In general, it may be said that it is suitable for the small levers such as those used for controlling the sparking mechanism, carbureter, etc. Another use for this metal is in bearings, although these require a decidedly different composition from that used for levers, crank cases, and like parts.

The parts requiring strength are usually made from nickel bronze, phosphor bronze, manganese bronze, or aluminum bronze, while the bearing bronzes are composed usually of lead, tin, and copper in various proportions. Under this latter head come also the so called babbitt metals which vary greatly in their composition, some of them being composed of lead, copper, tin, and antimony; others of lead, tin, zinc, and antimony, and still others of lead, tin, and antimony. It is not the purpose of the writer to discuss the merits of these various bearing metals, since a number of very good ones can be readily obtained on the market.

Beside the above alloys, pure copper is used to a considerable extent in the construction of radiators, gasolene tanks, etc. It is well adapted for the construction of radiators, since it can easily be soldered; is one of the best conductors of heat, and is readily formed into almost any shape on account of its malleability, ductility, and comparative softness.

Aluminum

Aluminum is now used very largely in automobile construction, and it is a significant fact that it was first introduced into the automobile in America, though the French used it to some extent quite early for a few minor parts of their machines. Pure aluminum is used only for a few special purposes, and even then to a limited extent—most notably for tubing and radiators. It is quite well adapted for the latter purposes in many respects, but the comparative difficulty experienced in soldering it is somewhat of a drawback. On the other hand, when alloyed with copper or some other metal giving it in-

creased hardness and elasticity, it is well adapted for various purposes such as seats, gear cases, crank cases, dashes, and various other parts of the car. Its extreme lightness, together with the ease with which it may be cast, renders it very useful for many parts of the machine.

An alloy of zinc and aluminum seems to have considerable rigidity and elasticity, as well as quite high tensile strength. It is also cheaper than the aluminum copper alloy, but experiments made by the writer indicate that this alloy is not safe if subjected to repeated vibrations, since it seems to fatigue quite rapidly and sooner or later breaks off short. For example, a ½-inch square bar made of an alloy of aluminum and zinc withstood only about 15,000 vibrations before breaking, while an alloy of copper and aluminum withstood 1,600,000 vibrations of the same amplitude and frequency without breaking or showing any signs of injury except a very slight set. Aluminum also forms a very light alloy with magnesium, which, however, is too expensive for ordinary use and is somewhat difficult to handle in quantity. A number of other alloys of aluminum have been prepared, and to some extent used in automobile construction—the most notable perhaps of which is an alloy of tungsten and aluminum, which has been used to a considerable extent used in automobile construction—the most notable perhaps of which is an alloy of tungsten and aluminum, which has been used to a considerable extent abroad, but is not used in American cars so far as the writer is aware.

	Modulus of Rigidity.	Elastic Limit.	Tensile Strength.
Aluminum alloys	8 to 11 millions	10 M to 15 M	20 M to 30 M
Phosphor bronze	12 to 14 millions	20,000	30,000
Manganese bronze	15 millions	35,000	50,000
Aluminum bronze	15 millions	50,000	75,000
Wrought iron	28 millions	30,000	40,000
Mild open-hearth steel	28 millions	40,000	60,000
Tool steel	29 millions	80,000	110,000
Nickel steel	28 millions	80,000	110,000
Nickel chrome steel	30 millions	160,000	180,000
Vanadium steel treated	30 millions	220,000	228,000

TABLE 2. STRENGTH OF AUTOMOBILE MATERIALS

From the foregoing it may be said that the following substances have proved suitable for the various parts of the automobile:

a For rear live axles, nickel steel containing from 4 per cent. to 5 per cent. nickel and less than 0.3 per cent. carbon.

b For front axles, steering knuckles, propeller shafts, etc., vanadium steel.

c For sliding gears, nickel chrome steel hardened throughout, or mild nickel steel case-hardened.

d For crank shafts, nickel steel or vanadium steel.

e For frames, low carbon open-hearth steel, mild nickel steel or nickel chrome steel.

f For nearly all other parts of the car, such as hand levers, tubing, etc., a good open-hearth steel of comparatively low carbon—say 0.4 per cent. or under—is of suitable quality, since there is no advantage gained by using high-class steels for these purposes for the reason that the rigidity of these parts is of prime importance, and in order to make them sufficiently rigid, they must be made much more than sufficiently strong; therefore, since all steels are practically equal in rigidity, one steel is, broadly speaking, as good as another for these parts.

The use of bronze should be restricted largely to minor parts; the reducing gear wheels, small levers, etc., can be made of phosphor bronze, while the bearings should be made of some good composition bronze—an alloy of copper, lead, tin and zinc answers well for this purpose, but the main bearings for the engine, such as the crankshaft, crank pins, etc., should be made of a special bearing metal, which is very firm and at the same time will not injure the crankshaft in case the lubrication becomes deficient. The crank case of the motor, the gear case, and other similar parts may well be made of aluminum, since it is light, strong, and easily cast into the proper shape. Steel would answer for the above parts if it could be conveniently worked into the proper form.

It will be noticed from the foregoing that the most progressive automobile builders have spared neither pains nor expense in obtaining the very best materials that can be produced, because in order to obtain the highest results in automobile construction, it is necessary that material of superior quality shall be used for certain parts of the machine. Perhaps there is no form of construction that taxes the ingenuity of its builders more severely than the building of a good automobile. Take, for example, one of the high-powered touring cars carrying from five to seven persons and equipped with a motor of 50 horse-power. Now consider that this motor is sometimes geared down to such an extent that its direct torque is multiplied ten or twelve fold on the rear axle; consider further that the driver of the machine is often entirely inexperienced, and to a large extent ignorant of the strength of the material and the use of power, and it will be realized that the chances for trouble when driving an automobile are certainly very great.

Now add to the stresses and possible abuses from the foregoing, the severe jolting and jarring of the rough roads in America, and some idea may be formed of the severe ordeal through which an automobile must pass during a season's run. It has been the general experience of builders that the more ignorant the owner of the machine, the greater his complaint. On the other hand, those who are versed in mechanical matters and who know the sizes of parts generally used for heavy stress, often marvel at the strength and endurance of the modern automobile. Factors of safety must be reduced to the minimum in nearly every part of the machine or excessive weight is sure to occur. Many high-class machines weigh less than 70 pounds to the horse-power, passengers included. Of course, it is not expected that the motor shall be used constantly at anything near its maximum horse-power—1/10 of its brake horse-power is enough for almost any automobile motor when in daily use; high power is simply intended to meet emergencies, but the material throughout the machine must be strong enough to withstand any stress momentarily applied. Table 2 gives the approximate strength of various materials used in automobile construction.

All of the above materials stand well under dynamic stress with the exception of the tool steel, which should not be used for this purpose.

Photographic Distortion

At page 1743, Vol. 27 (1904) Part 2, "Dixie" described a method of making templets by photography; this brought out several communications, in which the accuracy obtainable by this method was discussed. As having a bearing on this matter, the following statements presented to the Astronomical and Astrophysical Society of America, may be of interest:

Frank Schlesinger stated that the question as to the amount of distortion that a photographic film suffers during development is not yet settled.

Sebastian Albrecht had made investigations into the distortions of photographic films on glass plates; a preliminary investigation showed that if ordinary good care be taken in the treatment of the plate during development, fixing, hardening, washing and drying, there will be no general distortions, i.e., no distortions extending over a large area of the film. Accordingly, the work was continued by a method which would more readily determine the character of *local* distortions. These distortions very rarely covered an area as much as 0.25 m.m. square; the displacements of individual points in the distorted area occasionally amounted to 0.02 m.m., but such large displacements were extremely rare.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Re-boring a Gas-engine Cylinder

The shop that I have charge of is one of the typical Southern repair shops, with three or four lathes, drill presses, planer, etc., as usual in single-barrel repair shops. Our class of work runs all the way from a typewriter to locomotive and steam-engine repairs; one thing today and something else tomorrow; we never know what to expect, consequently have ceased to expect anything in particular. One day I found myself facing the problem of re-boring the cylinder of a small gasolene engine, 4½ inches in diameter. The frame and cylinder were all made in one casting, and only one end of the cylinder was open. The crank case obstructed the other end and consequently I could not run a boring bar through it, and bore it in the lathe as all repair-shop men have done so often. I had no vertical mill to swing it in, and the large drill press would not take it.

But the cylinder must be bored.

Using Old Piston for Boring Bar

So after filling my cob pipe and smoking it down the second time, here is what I did. I took out the old piston, cut a slot across the open end ¼x1½ inches, to fit an old bastard file; annealed my old file, cut it off square on both ends to 1/32 inch larger than the largest diameter of the cylinder, rounded the cutting corners in the usual manner, tempered it and tapped it lightly into the piston with a hammer, being careful to divide it equally at both ends.

There was a hole in the forward end of the piston tapped to 1¼-inch pipe and plugged. This plug I removed and screwed in a piece of pipe about as long as the extreme length of the cylinder, put an ell on the other end, and made a crank of the pipe. I then put the whole rig into the counterbore of the cylinder and began to bore by hand just to see what would happen.

The counterbore was plenty long to give a support for my guide, which was the piston, and it started off all O. K. I soon discovered that I did not need a feed other than a slight pressure on the crank. I put a boy on the crank and told him to get busy, and departed. In half an hour I returned and found the boy sitting on a box examining his hands very critically.

The Boy Objects

When I looked in the cylinder I discovered that the cut was half way through and doing nicely, but the boy protested in no uncertain terms against the wear and tear of his hands. However, after patting him on the back and explaining to him that he was doing a journeyman's work boring cylinders, he took the bait and resumed work like a good fellow, with the result that in another half hour the cut had gone through. I calipered it, and found that it was not any worse off than before the cut had been taken, and it did look as though it had been rebored.

I fitted in a new piston just as tight it would go to slide freely, put in new rings, set it up and started it on a test run, there in the shop. We had quite a bit of coaxing to get it started, and it "blowed" through at first as bad as it did before it came to the shop. After running an hour I took out the piston and scraped the rings to a nice fit all round the circle, put them back and started off again. This time it "blowed" a little, but not enough to be noticeable, and I let it run along for 10 hours without a stop.

Starting It to Work

Putting a piece of 2x4 under the flywheel, the power felt good to me, and I decided that it was equal to the load it was billed to carry. So I hauled it up to the printing office, set it up and coupled on the load. In two days I stopped it to take a look. It had been running 10 hours per day, and I was surprised to see that it was as tight as the average engine that comes from the manufacturing shop.

It has now been running regularly 10 to 15 hours per day for two years, and the owner makes his boast that he has the best engine in town; the most peculiar part about it all is that he is right from an economical point of view, and there are 16 other gas engines in our town. We do all their repair work, and for the two years our books show that the man who owns this engine has paid us less than any one of the other 16 for repairs; his gasolene consumption is about the same as the others that have the same amount of load. How is that for a makeshift?

Now I like mechanically perfect work as well as anyone, but when there is no other way of getting out of the tree besides falling out, why I can just fall out with as good a grace as the next one. I am a great believer in the man who has the habit of doing things whether they be possible or not—just do it. John.

A Cup Handle and Its Tools

The cuts show a finished cup handle, the finished blank from which it is formed, the blank-forming die and the handle-bending fixture.

Fig. 1 shows the finished handle and the blank.

Description of the Blank-forming Tools

A Fig. 2 is a wrought-iron die head in which a dovetailed groove is planed to receive the edge forming part *C*, and which is fastened in place by means of two

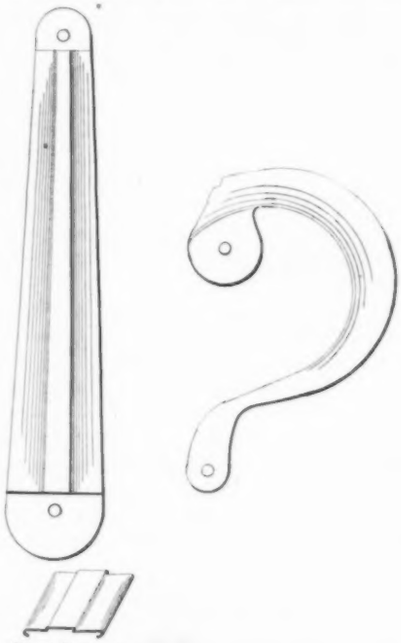


FIG. 1. FINISHED BLANK AND HANDLE

screws from below. The screws are not shown. The rib forming die *D* is shaped as shown and is fitted to slide up and down in *C*. Two holes for the pins *E* are drilled and reamed through part *A* and *C* and transferred into *D*. The pins *E* have a sliding fit in *C*, are driven into *D*, and are of such length that when the upper part of *D* is about ⅛ inch above the cutting die *L* the lower end of the pins will be about ¼ inch above the pressure plate *F*, which is held against the bottom of the die bed by the rubber bumper *G*. The two die bushings *V V*, Fig. 3, are also put into *D*. These are for the rivet holes.

The two holes *H*, Fig. 3, are then drilled and countersunk to receive the bushings *I*, which in connection with the two light springs *V'*, act as a lifting device

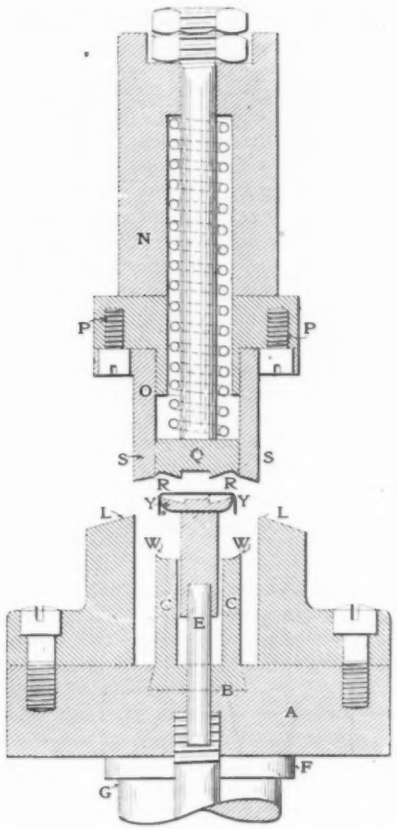


FIG. 2. BLANK-FORMING PUNCH AND DIE

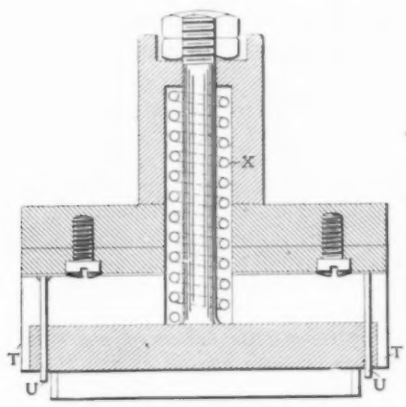


FIG. 4. BLANK-FORMING PUNCH

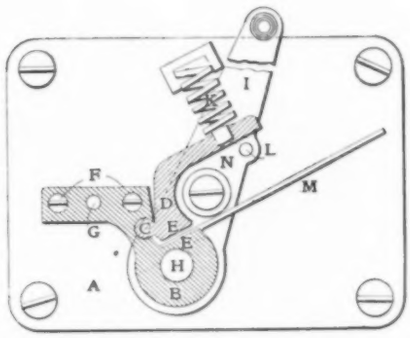


FIG. 5. CUP-HANDLE BENDING FIXTURE

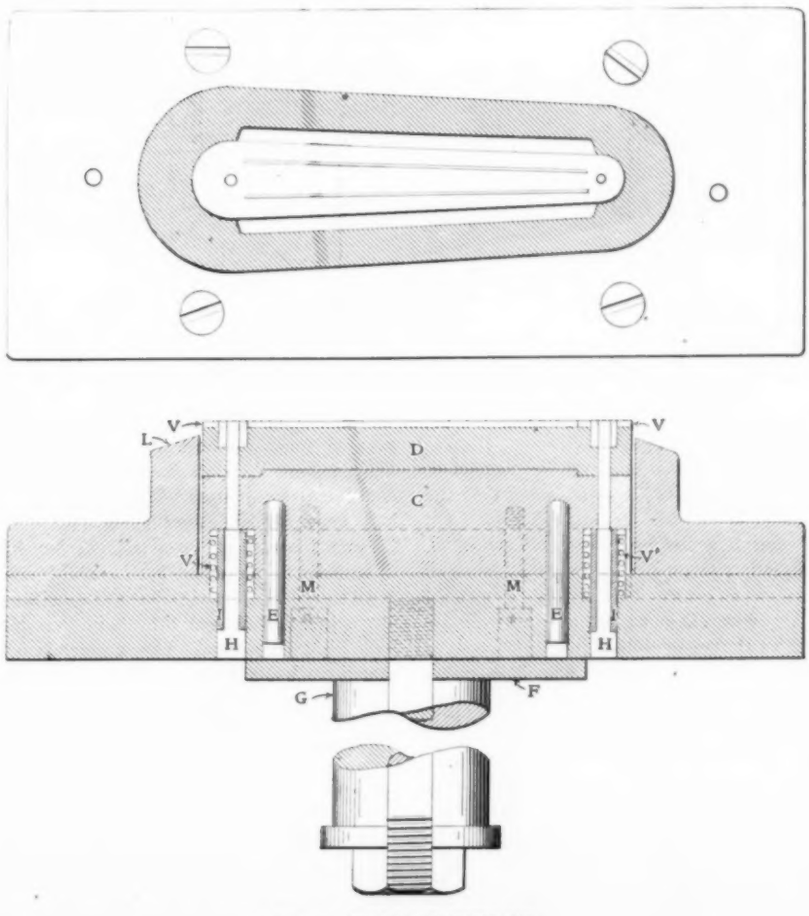


FIG. 3. BLANK-FORMING DIE

for part *D*. These hold *D* in such a position that its upper part or face is ⅛ inch above the cutting die. To prevent the former *D* from traveling too high above the die, two screws *M*, Fig. 3, are let through the die bed and tapped into *D*.

The cutting die is then finished to size and hardened.

The punch is shown in Figs. 2 and 4. It consists of the steel shank *N*, the cutting part *O*, and the knockout *Q*. *O* is fastened to *N* by the four screws *P*, and two dowel pins. The inside of the cutting punch at *R R* is made to fit snugly over the part *C*, at the points *W* in the die. The knockout *Q* is then finished, to conform with the shape of part *D* of the die, Fig. 2.

Allowance is made for two thicknesses of metal between the inside part of the punch at *R* and the rounded edges of forming part of *D*. The outside of the punch is then fitted to the cutting die.

The circular ends of the punch as shown at *T*, Fig. 4, are cut away, so as to allow the straight sides of the punch, marked *S*, Fig. 2, to cut through the metal first. The two holes for the piercing punches *U U* are transferred from the die into the punch and drilled, and the punches inserted. The punch and die are then put together, and the four screw holes drilled which hold the forming and cutting parts of the die together. The die is then assembled. The springs *V'*, in the die Fig. 3, must be very light, and the spring *X*, in the punch, Fig. 4, must be stiff enough to compress both springs *V'* with ease. The die was made to use on an inclinable power press, the narrow end of the die being put toward the back.

Making the Blank

In use the descending punch clamps the stock to the former *D*. The cutting edges *S* of the punch, cut through the metal at the straight sides first and bend these sides down at right angles over the corners of *Y* past *D* by the action of the inside corners *R* of the punch. Continuing the stroke the punch carries these bent down sides into the curves *W* of part *C*, and with the inside part of the punch moving upward, the downward bent sides are forced around *Y* into the curves *W*. When the sides start to curl the rounded ends of the punch *T* cut the ends of the blank loose, and the two rivet holes are punched. As the punch rises part *D* with the blank formed around it is lifted up by the rubber bumper, and to a point above the cutting die by the light springs *V'*. It is then ready to be stripped from *D* by the operator.

The Bending Fixture

This fixture is shown in Fig. 5. *A* is a bed-plate carrying the forming devices. *B* is the steel former, which is partly cut away on the bottom side to admit the lever *I* to swing around the pin *H*. At *F*

are shown screws and at *G* a dowel pin, which fastens together the bed plate *A* and former *B*. The clamp *D* is hinged at *C* in *B*, and the two clamping faces *E* are forced together by spring *K*, when the lever *I* is turned to the left, thus clamping the blank and holding it while being formed. Upon turning the lever to the right, the pin *L* will open the clamp, and release the finished cup handle.

The sketch shows the end of the handle *M* clamped ready for the roller *N* to bend it.

It is evident that a handle made in only two operations is very cheap. The total cost of labor on these handles was only 55 cents per thousand.

JULIUS F. A. VOGT.

Making a Pattern Lathe out of an Engine Lathe

Some time ago I had occasion to replace a wood lathe in a pattern shop of which I had charge.

The company was "heavy" on the economy talk just at that time, and as we had an old flat-way engine-lathe bed, with the legs, that we did not know what to do with, it occurred to me to use it and make a lathe.

The only thing about that lathe that was out of the ordinary was in the design of the tailstock, which I think must be new, as neither the patternmakers nor myself ever saw or heard of it before.

Instead of running the tail spindle in and out with a screw and handle, as is usually the case, I simply bored the hole for the spindle straight through and made it of such a length that when it was out its extreme range, I still had about 4 inches projecting out of the rear end. This projection was nurled.

There is not the tendency to crowd the spindle back in a wood lathe that there is in lathes for metal; consequently, I needed no other means than the clamp to hold the spindle to its place.

The advantage of this method can be readily understood by patternmakers, especially those accustomed to turning large heavy patterns.

By the time a workman has held the work up with one hand while he runs in the spindle with the other, his hand has begun to shake so that he is quite apt to strike the piece somewhere else than where he wished to. With the straight spindle he can instantly bring the center to the work, and as this spindle is very much more sensitive he can remount the work with less liability of shaving the center, thereby throwing the work out of true.

I made the bearings of this lathe more than twice the size that lathes of that swing are usually made, and I get better results.

G. S. HALEY.

Apparatus for Raising Counterweights of Boring Mill

With the electric-driven machines, the superintendent of a shop does not hesitate to move them when they are in the way. But, some of them, like the boring mills, though they do not need foundations, require a pit for the counterweight. The apparatus shown has been devised to overcome this need, and gives entire satisfaction.

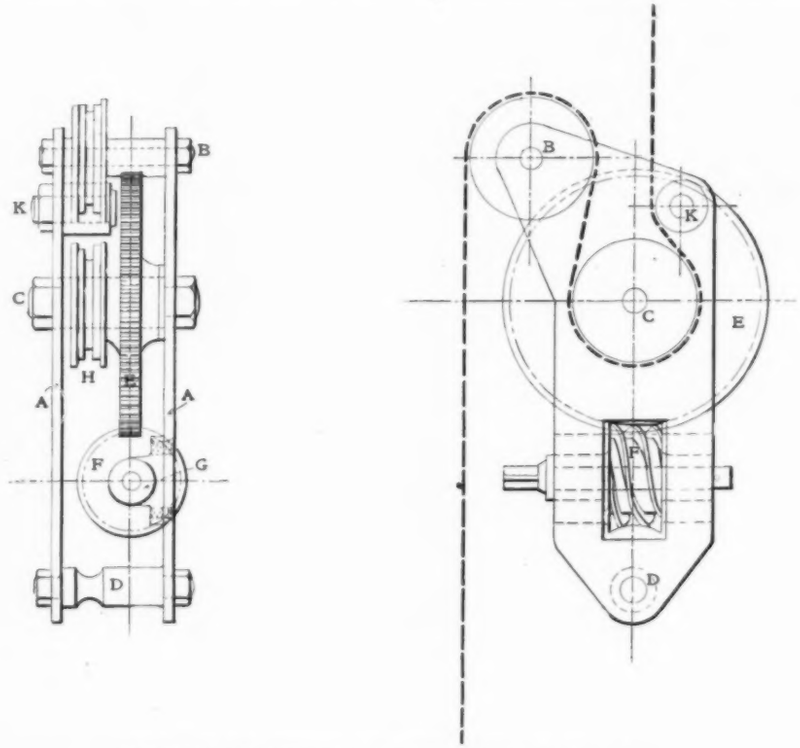
Two boiler-plate flanges *A* are braced together by three bolts *B*, *C* and *D*. The central one *C* is used as the axle of a worm gear *E*, driven by a 2- or 3-thread worm *F*, supported with two brass sleeves *G*. These are screwed on one of the flanges, cut open for the passage of the worm.

The axle of *G* is squared on one end to the size of one of the feed screws of the mill, so as to use the same handle. On the gear *E* is fixed a chain-gear wheel *H*, and both run on *C*. A guide runs on *B* the same as on *K*. The weight is fastened to *D*. The chain passes through the device, as shown by dotted lines.

When the cross bar of the mill is going up, a few turns of the handle on *G* keep the apparatus climbing the chain, which can fall into a sheet-steel can attached on the side of the weight.

A cast-steel frame has also been made, but does not look much better than the cheaper frame here described. With the distances of *K* and *B* to the center line well chosen, the complete fixture keeps vertical.

P. F.



APPARATUS FOR KEEPING COUNTERWEIGHTS OFF THE FLOOR

Criticism of the Technical Schools

On page 705 W. Alton pleads for a let-up in the "roasting" of the technical schools and their graduates. I say, "Hit 'em again and hit 'em harder." They are doing good work; they are doing better work every year; and the only reason why they are doing better work is because of the criticisms of practical men. The people in control of these schools are in general college men with the college idea that anything useful is rather beneath their attention, and if you and your readers do not keep after them they will slump back where they were 30 or 40 years ago.

For W. Alton to tell your readers that the shops have better chances to pick their men than the schools must make a large part of your readers sit up and laugh. Why, I went through one of these schools and I had to sit up nights and study my hair gray for six months beforehand to be sure I would get in at all. A boy has to be bright enough so that he could make a pretty good show in the world without any education before they will let him look inside the door. The wonder is, not that the schools do so well considering the boys they get, but that the boys do so well considering the kind of teachers they have.

I remember well that I took for one study steam engineering. Before I went there I had knocked up against quite a few engines, and I found, and so did the "Prof.," that I knew more that was really so about an engine and boiler than he did. We had a picnic that term. He hated to have me in his class, and the rest

of the boys would give up a ball game to come.

The work of a teacher who knows every word in his text-book and knows the right answer to every problem he gives out, does not do the boys one bit of good when they come to face the world. What the boys need is contact with some man who has rubbed the world long enough to realize that he must admit a doubt as to the accuracy of a great deal of his teachings. Your readers can accomplish much by criticizing the technical schools, so as to drive the professional educator from this line of work and leave room for the educated shop man to whom education is a means to an end, not the end itself.

OLD GRAD.

Fixture for Cutting Keyways on the Shaper

The accompanying drawings represent a splining bar and fixture that were designed for holding work, especially for splining milling cutters, but which could be used for other work.

In the shop where this fixture was made and used it had been the practice to mount the cutter blanks, before milling the teeth, in a chuck or upon a face plate m the lathe and cut the spline with a tool mounted upon the carriage, the carriage being run back and forth by hand. This proved an arm-breaking and cuss-word evoking job, as there were a lot of them constantly coming along to be splined; but the advent of the bar and fixture herein described quite changed the aspect of the universe to the man on the job, inasmuch as splining cutters became almost a pleasure, and incidentally a few dollars were put in the boss' pocket.

Fig. 1 shows a side view of the bar complete, Fig. 2 a top view, Fig. 4 an end view, and Fig. 3 a side and end view of the cutter.

The bar was made of tool steel packhardened and ground, at *d*, Fig. 1, to a working fit in the holes in the cutter blanks, which were reamed 0.006 inch under size to allow for grinding after hardening.

At *c*, Fig. 1, the bar was turned about 1/32 inch smaller than at *d*, to do away with unnecessary friction and trouble in fitting. At *b* the bar was ground to fit the hole in the clapper block of the shaper in which the bar was used, the thickness of the shoulder at *a* being fitted very carefully to the depth of the recess in the clapper block, so that when the bar was put in place and the clapper block bound down by two screws *u*, Fig. 7, the bar was held securely against any turning or end movement, and at the same time was not forced out of line with the shaper ram.

The cutter *f* was made of tool steel and was left rather hard, as it was well supported against any bending strains by being fitted closely to the slot milled completely through the bar. The hole in the cutter was made a running fit on the pin *i*, the pin being a drive fit in the bar. The flat spring *g*, Fig. 1, was held in place by two screws *h* and pressed against the side of a notch *j* let in the cutter, Fig. 3, the pressure of the spring tending to throw the cutter upward, away from the work, and the turning of the nurled screw *e* tending to force it down, the point of the screw bearing against the rounded back of the cutter.

The cutter had clearance from the cutting edge upward, and from the cutting edge backward the clearance was very slight, so that the cutter could be sharpened repeatedly by grinding off in front, without changing the size of the spline materially.

The fixture for holding the work, shown in side view Fig. 5 and front view Fig. 6, consisted of the cast-iron angle plate *k*, Fig. 5, the long shoulder bolts *n*, the collars *o* and the clamp *p*. The angle plate had a hole bored through it 1/8 inch larger than the largest splining bar used. The clamp *p* had a hole of similar size.

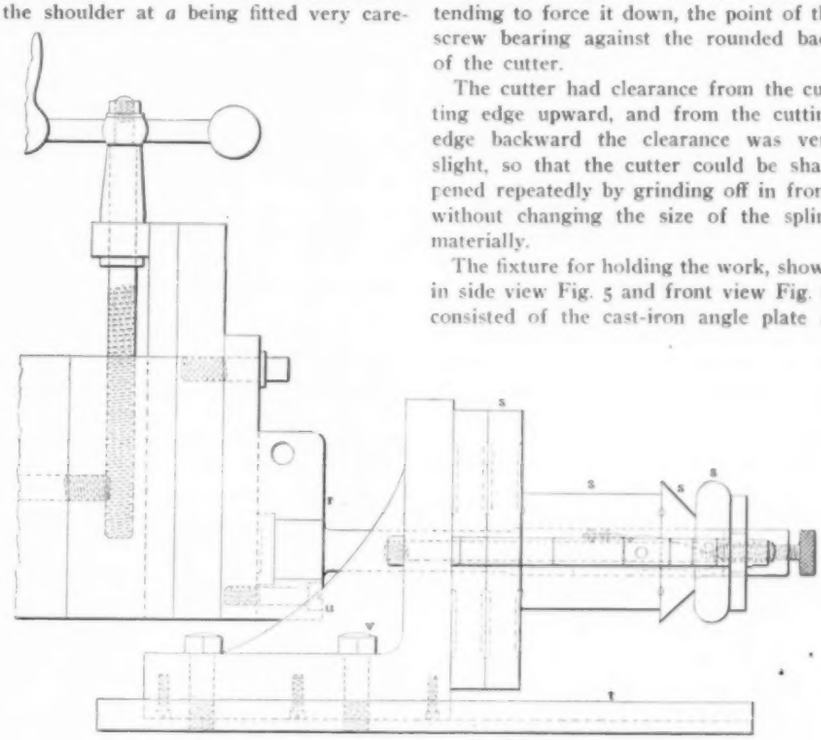


FIG. 7. FIXTURE IN POSITION ON THE SHAPER

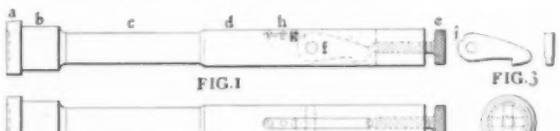


FIG. 1

FIG. 3

FIG. 2

FIG. 4

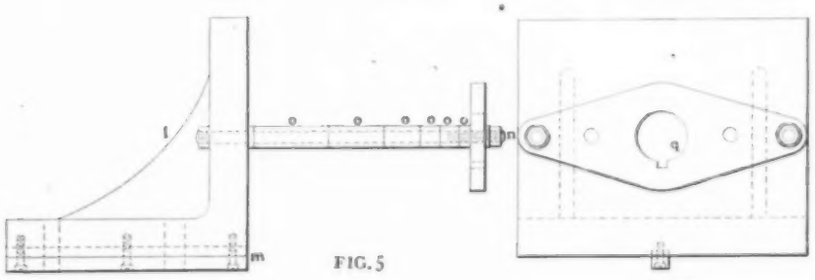


FIG. 5

FIG. 6

THE KEYWAY CUTTING FIXTURE

In operation the screw *e*, Fig. 1, was turned back until the cutter came up inside the bar. The clapper of the shaper was then raised, the regular tool post removed and the splining bar put in its place. The clapper was then fastened down securely by the two screws, as shown in Fig. 7, binding the bar firmly in place.

The knee of the shaper was then brought to such a hight and lateral position that, when the angle plate was put on, the hole in the latter registered approximately concentric with the bar. The angle plate was then put on, the bar passing through the hole in it, and fastened down by three hexagonal-head screws, the key in the bottom of the plate fitting in one of the slots in the shaper bed, locating the plate laterally and at right angles to the bar.

The shaper ram was then brought forward until the entire working length of the bar was in front of the angle plate, the clamp and collars removed, the cutter blanks slipped on the bar and pushed back

against the angle plate, the clamp replaced and the nuts screwed home, binding the cutter blanks firmly against the plate.

The stroke of the shaper was then adjusted so that the cutter came past the ends of the blanks on both the forward and back strokes, and the shaper started.

The tool cut on the backward stroke of the shaper ram, the belt being crossed. As the bar came through the front end of the blanks, the screw was given a slight turn to the right, forcing the cutter down to the work; on the return stroke the cutter was pulled through the whole length of all the blanks, the chips flying out back of the angle plate. At each succeeding stroke of the shaper ram the cutter was set down a little farther, there being ample opportunity for the fingers to grasp the screw, turn it and let go from the time it first protruded through the blanks until it was drawn back by the return stroke of the ram. Oil was occasionally squirted in at the top of the slot in which the tool worked and, running down around the bar and the edge of the tool, lubricated both the cut and the bar in the blanks.

Fig. 7 shows the bar and fixture in place on the shaper and a set of miscellaneous blanks clamped on in readiness to be splined.

The collars shown on the bolts in the face plate were not used when the fixture was worked up to its capacity, but were provided to be put on between the clamp and the nuts when blanks aggregating a shorter length than those shown in the drawing were to be splined.

One lot of blanks could be removed and another lot put in place in a few minutes, as there was no adjusting to do aside from simply stringing the blanks on the bar and fastening with the clamp.

As everything was rigidly braced and there was no possibility of the cutter springing away from the work, a cut as heavy as the shaper belt would pull could be taken at each stroke.

The braces on the angle plate were so spaced that the shaper head could come between them right up to the angle plate, thus doing away with any extra length of bar.

This device worked to perfection. Three sizes of bars were made, for 7/8-inch, 1-inch and 1¼-inch holes, and 1/8-inch, 5/32-inch and 3/16-inch keyways.

GORMAN DIZER.

Boring the Head of a Large Punch

We build a line of dyeing machines and use a steel perforated cover for them. We have been accustomed to drill all of the holes in these covers, and as they number about four thousand to the cover, it is quite a large job.

So we determined to build a punch for this purpose. Not having a swivel head on our radial drill or a regular boring bar with screw and star feed, we bored this punch casing with a 2 15/16-inch shaft supported by a bearing on each end of the punch. A round casting with a hole for the boring tool drilled at right angles to a 2 15/16-inch hole through the casting and fastened to the shaft by set-screws was our boring head.

The tailstock was removed from our 24-inch lathe and the punch casting placed close to the end of the lathe bed, as shown. A 1 7/16-inch shaft was connected to the boring bar by a coupling and supported on the other end by a piece of 1x3-inch iron clamped to the lathe carriage.

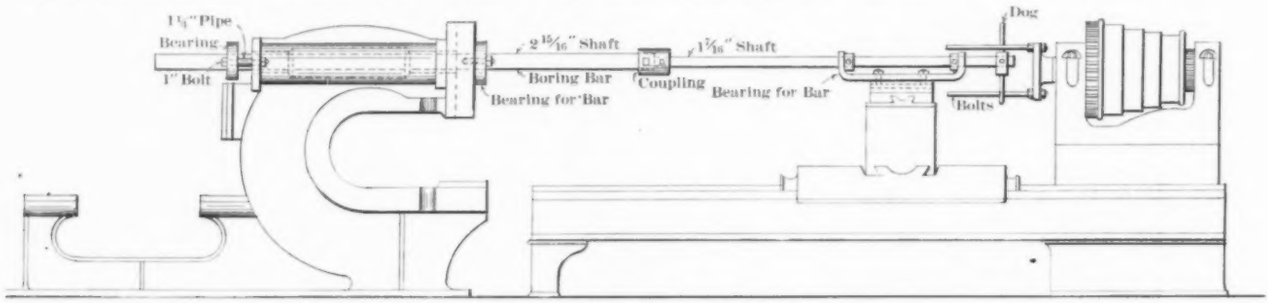
A driver was fastened to the 1 7/16-inch shaft between the carriage and the headstock, and two long bolts were fastened to the face plate of the lathe.

These bolts drove the boring bar. The carriage, with the help of a set collar on each side of the 1x3-inch piece of iron, provided for the feed and the job was finished without the aid of a better equipped shop.

You will notice that the head of the punch is chambered, and since this chamber is cored we had only 8 inches to bore on each end of the punch; therefore we did not need very long bolts in the face plate of the lathe. There are two holes in the boring bar for carrying the boring tool, one at each end of punch, and the two ends are bored independently of each other.

I merely send you an outline sketch, leaving off all superflous things, such as the back gears of the lathe, the feed gears, etc. I may add that the 2 15/16-inch shaft we used for a boring bar was used later in the lower bearings to carry the tight and loose pulleys and the pinions.

E. R. SEITER.



BORING THE HEAD OF A LARGE PUNCH

A Plea for the Diagram Hand-book

The able summary of the advantages of a diagram handbook in your editorial on page 646 makes its production a definite possibility. To a person of sanguine temperament it would seem that it only remains necessary to arrange for the details, editor, material and publisher. These notes are written from the viewpoint of the remaining element, the possible purchaser.

First, as to form—loose-leaf or bound volume. Some time ago the merits of the card index were set forth as follows:

Accessibility—Always get-at-able.

Expansibility—Can enlarge forever and still be useful.

Order—New material can be inserted in exactly the proper place.

Adaptability—Suits every frame of mind and line of work.

System.

Divisibility—Parts (cards) can be removed for temporary use anywhere.

Labor-saving—Nothing has to be rewritten.

Simplicity.

Contractibility—No need of retaining useless or outgrown matter.

No waste of space.

Always up to date.

Rearrangement easy.

The card index is of advantage, but all these advantages apply even more strongly to the loose-leaf book when compared with the bound volume. Therefore we will assume the loose-leaf form for our diagram handbook.

What is the best size of page? Pocket-book, hand-book or desk-manual size. If it is to be a pocket-book, the first logical step is to measure one's pocket. A book 4¾ inches wide by 7¼ inches high by 1 inch or 1½ inches thick will slip easily into the average pocket. Now as the page of the usual hand-book is about 4 inches wide by 6¾ inches high, it answers admirably, leaving ¾ inch in width for binding rings and indexing tabs. Here is a good beginning; the publishers may use their present plates.

One of the most satisfactory pocket-books is a copy of Sames, interleaved as required bound in a loose-leaf binder. It is very convenient.

If you have a job that requires a little

electrical computing beyond the reach of the slide rule, a few folios on electrotechnics may be taken out and a table of logarithms or sines or what-not from an old hand-book substituted in their place.

The cost of such a book is about as follows:

One good quality loose-leaf binder	$1.75
Filler for interleaving	0.25
Copy of Sames (first edition)	1.50
Estimated second-hand value of books cut up for inserts	4.00
Total	$7.50

This represents the price paid for compactness, or shall we say for the loose-leaf fad.

Considering the hand-book or 6x9-inch page, a good example of diagrammatic treatment is found in Scott's "Structural Designer's Handbook," and shows what may be done along this line. It should be mentioned that most 6x9-inch pages may be cut to 5x8 inches without sacrifice. This also applies to the standard magazine page, and is a good argument for the 5x8-inch size.

As a desk manual, Hawksworth's "Reinforced Concrete Design" is a good example in quarto form, and in a loose-leaf holder would allow the insertion of the 8x10½-inch or 8½x11-inch ordinary letter sheets. Could a book of this kind contain 500 pages and be sold for $7.50 or $10? A valuable example of loose-leaf methods is found in the practice of some of the electrical companies and other large concerns in issuing descriptive bulletins which may be filed together in a binder. The same methods could be applied to the publication of a hand-book which could be purchased in sections as required. This is the fundamental thought of my whole proposition. A series of monographs, each prepared by an expert and put together in loose-leaf form.

Reverting to the subject of cost, the average man possesses possibly two hand-books, for which he paid about $8 or $10. Each deals in a way with from twenty to forty subjects or general topics of engineering. In the two books from ten to twenty subjects are duplicates and some twenty-five are of no use. In other words, twenty-five or thirty subjects cover the reference needs of the average man. Sames costs about one cent per page; Kent, Supplee and Trautwine about one-half cent per page; Kidder about one-third of a cent per page. Therefore for 25 cents we should be able to purchase a section of from 25 to 75 pages covering a given subject. Our twenty-five or thirty subjects will then cost about $8, which, with a binder and index tabs, will bring the total cost to about $10. This is a book that may be added to as required, need contain no dead matter and will be a joy to its possessor.

Thus far only the mechanical get-up has been dealt with. We will now consider the contents, a more delicate subject, as it implies criticism of the present hand-books. Let us have a good selection of mathematical tables. As an example, give a good five-figure table of logarithms, 50 to the page, grouped in blocks of 10; if a table of proportional parts can be added, well and good; but let us have clear, open, uniform spacing and a high-grade, tough paper, not the flimsy material of the ordinary hand-book. Give us squares, cubes, roots and reciprocals grouped in the same way, 50 to the page. The Carnegie "Pocketbook" has a good arrangement of this table. Let us have (an innovation) logarithms of the trigonometrical functions. If necessary, leave out tables for the weight of cast-iron balls, tables of board measure and the like.

Let us have more thorough editing, not mere compiling; and right here is the place for the proper use of diagrams. For instance, any number of formulas within limits may be used in designing thick cylinders; but when these various formulas are plotted graphically, the limits of application are readily seen. So with column formulas and others differing considerably in form that give substantially identical results when used within certain practical limits. The diagram will show these limits at a glance.

All designing involves a comparison of data, and this comparisin is most readily grasped when in the form of a diagram. Take a simple illustration: It has been easy to remember that the center-breaking load of a bar of cast iron 1 inch square 1 foot long is 2000 pounds, or 1 ton, and that the strength is proportional to the

$$\frac{breadth \times depth^2}{length}.$$

Suppose we are told that the result of recent experiments shows the strength to be proportional to the

$$\frac{(breadth)^{0.82} \times (depth)^{1.89}}{(length)^{1.658}}.$$

Then put these formulas in the shape of a diagram and comparison becomes simple and the law of these changes evident. This is the work the editor must do.

Let us have a book we can all use. Give the simpler forms of things first Ninety per cent. of belting problems may be solved from the elemental relation, 1000 feet of 1-inch belt per minute = 1 horse-power. The remaining 10 per cent. may require Lewis' diagram or perhaps a reference to Nagle's table as given in Kent. Remember, a hand-book supplements but does not take the place of a text-book. In a hand-book we want results.

Finally—Let us have diagrammatic treatment. Any engineering formula may be represented by a diagram not larger than 3x5 inches or at most 4x6 inches. Put this diagram on a page large enough to have the formula and derivations with it. Put these pages in a *flat-opening* loose-leaf book and a considerable number of us will be ready to buy it when it is issued.

J. A. Brown.

I wish I had time to write a few words on "Charts vs. Formulas" for the benefit of those who still "rut along" with the formula. Just imagine the busy superintendent working out the strength of I-beams, resistance of flues to collapse, etc., if there were suitable charts within *get-at-able* distance. If a modern designer were to spend a large percentage of his time in solving numerous formulas, then his pay envelop would certainly decrease in an inverse ratio. Oh, yes! the formula is condensed knowledge. For instance, there is the formula for obtaining logarithms, which is vastly more condensed than the full table; but would anyone attempt to use it in practical work? No! and the same with nearly all other formulas. They are too slow and waste too much time before giving results.

G. P. P.

Lead or Pitch?

The article by Arthur B. Babbitt, at page 703, "What Are Lead and Pitch of Screw Threads?" I take for an invitation to give opinion and reasons as to what should be called "pitch" and "lead."

I will not endeavor to "straighten out" the "confusing combinations of the shop men," but I want to give my reasons why the distance from center to center of adjacent threads should be called pitch, and why the distance traveled by the carriage during one revolution of the work, when cutting a screw, should be called lead. Further, I want to show how definite information should be given on drawings, concerning the cutting of screws, so the shop man, no matter what his opinion, cannot possibly make a mistake.

The distance from center to center of adjacent threads of a screw should be called pitch, for the reason that we call the distance from center to center of adjacent teeth of a gear or rack pitch. By calling it pitch in this case we refer to the equal spacing of the teeth.

Supposing we cut two flats on each side (opposite) on a mutiple-threaded screw and look upon the threaded portion that is left, we would see a rack the teeth of which are standing more or less at an angle, according to the number of threads. By looking at it we could not tell how many threads the screw had; in other words, we could not tell what the *pitch* of the thread was if we called the lead, pitch. But we could still measure the distance from center to center of the *adjacent* threads, which is the pitch proper.

When cutting a multiple-threaded screw on the lathe, we should call the distance

traveled by the carriage during one revolution of the work lead, for the simple reason that the screw which moves the carriage is universally called the lead screw.

When giving information on drawings as to the cutting of the thread on a screw, whether the thread is single or multiple, both the pitch and the lead should be given. If the thread is single, ½-inch pitch, the information on the drawing should read thus: ½-inch pitch, ½-inch lead, single thread.

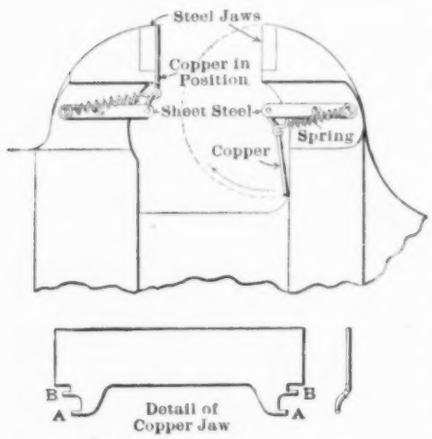
The operator of the lathe must always set his gears on the lead screw according to the lead of the thread he is going to cut, whether single or multiple; therefore we should tell him on the drawing what the *lead* of the thread should be, even in the case of a single thread.

The information for a multiple-threaded screw should be given thus: ½-inch pitch, 1½-inch lead, triple thread; or, ½-inch pitch, 2-inch lead, quadruple thread; etc. Also in giving information of a multiple-threaded worm it is most proper to call the distance of the adjacent threads pitch, as this distance is also the pitch of the gear which runs with it.

JULIUS G. KREIS.

A Safe Vise Jaw for Toolmakers and Others

Everyone who has to clamp finished work in a vise knows the disadvantages of the ordinary jaw caps of copper or lead. They usually fall out at the wrong



TOOLMAKERS' COPPER VISE JAW

time and are seldom true enough to clamp a piece of work exactly even.

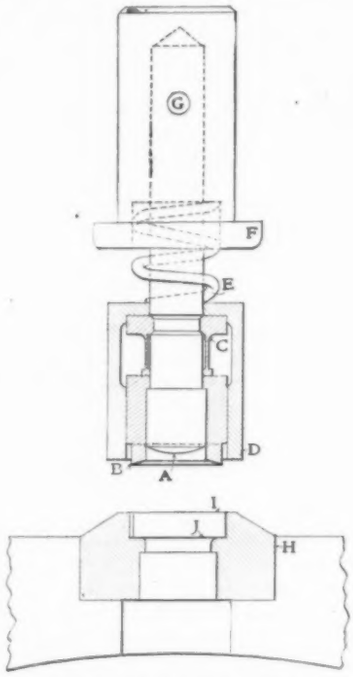
The strips of sheet steel are screwed to the side of the vise just under the jaws themselves. These carry the lower pins or trunnions of the copper jaws *A A*, while the springs hook on to *B B*.

The sketch shows the left-hand copper face in position and the right face swung down out of the way. It's a good scheme. Try it. C. W. PUTNAM.

A Combined Blanking and Forming Die

The accompanying sketch is a combination blank and forming die for brass caps for carriage-bolt heads, such as are used in laundry machines.

A is the forming punch; *B* is the blanking punch; *C* is a split sleeve which catches in the groove cut around the



COMBINED BLANKING AND FORMING DIE

forming punch; *D* is a sleeve that locks and releases the blanking punch.

The coiled spring *E* pushes the blanking punch back and locks it as you see it on the sketch. *F* is the punch holder; *G* a pin through *F* and *A*; *H*, the die pressed into an iron block; *I*, the blanking part, and *J* the forming part of the die. The shoulder on *B*, near the cutting edge, is to hold *B*, while *A* goes down and forms up the cap.

I think the sketch is plain, although it is a little out of proportion. I made one of these dies last week, and find it a great success and time-saver. On the old dies we have at the shop, the operator must push the caps away from the die and get his fingers under the punch, where on this new one the caps fall through into a box below. I have never seen anything like this before. GEO. SIMON.

Hardening in Sulphuric Acid

After the letters which have appeared from time to time in the AMERICAN MACHINIST condemning the use of sulphuric acid for hardening purposes, it is quite refreshing to read the article on "Hardening Drills," on page 488.

The writers who have condemned the use of sulphuric acid for this purpose have invariably done so on the ground that it rots the steel. If this were true an ordinary drill would stand a poor chance under this treatment. My experience during many years is that there is no truth in this statement of injury to the steel, and have no hesitation in saying that for [illegible] drills, formed cutters and milling cutters there is no cooling liquid in the use of which there is less risk of fracture and which holds such possibilities of satisfactory results.

BLACKSMITH

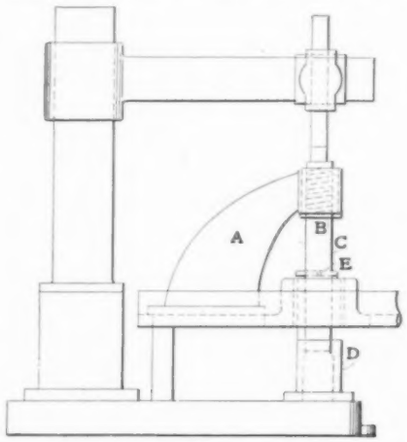
Threading a Face Plate on a Boring Mill

There came to the shop a 60-inch face-plate to be bored and chased 8 inches and 2 threads to the inch. It was a simple enough job providing there was a lathe large enough to swing it, which there was not; hence the problem, and this is the solution: There was a big radial, so the job was placed thereon and blocked up on timbers, one of which is shown. Then the arched casting *A* was bolted on and was bored to receive nut *B*, which was chased 2 pitch.

The bar *C* was fitted to the nut, and made long enough to reach from the drill spindle, through the work, to the guide *D*, below the face-plate.

While this rigging took some time to make and set, the operation was very simple.

A square hole at *E* received a piece of ⅝-inch square Novo steel, which was reduced to ½ inch at the end. When the



THREADING A FACE PLATE ON A BORING MILL

bar was raised to the top by means of the backing belt, the cutter was inserted and the machine started.

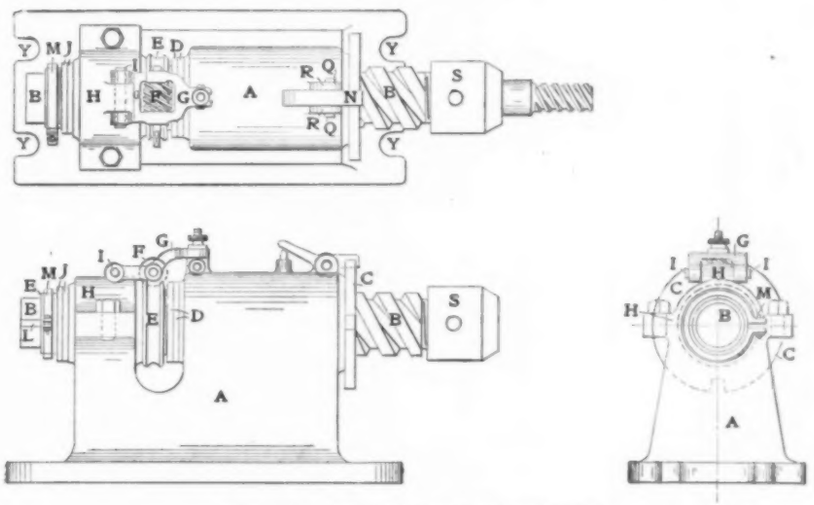
The nut drove the bar down and took out a liberal cut. Then the set-screw was loosened, the cutter removed and the machine backed until the bar reached the top, the cutter reinserted, and the operation repeated. The final result was surprisingly good, and not so expensive as at first may seem. EDWARD THOMAS.

Fixture for Cutting a Quadruple Lead Spiral Thread

Having about 650 machinery-steel rods, 1 inch diameter, which required a quadruple spiral thread 3-inch lead, ¾-inch pitch, cutting on the end, for controlling the motions of a textile machine, we designed the fixture shown, and for speed and accuracy it was all that could be desired. Our universal milling machine could not be monopolized for the job, being kept going on toolroom work, and the lead was too coarse to cut on a lathe, besides being a very difficult job.

The base *A* is a gray-iron casting, cored out at the bottom, *B* is a master, or former screw, 3-inch lead triple thread, and cut very shallow. This works through the steel nut *C*, which has a dividing plate turned on the front end with four notches cut in, and extends back through *A*. It is kept in position by the two locknuts *D*, on the back end. The worm wheel with sleeve *E*, is a good fit between the end of *C* and the faced end of the cap *H*, has 16 teeth and gears with the quadruple-thread worm *F* carried in the bracket *G*. This swings on *H*, by the pin *I*. *J J* are two locknuts on the end of *E*. *L* is a keyway ¼-inch wide, cut in the back end of *B*, where it is reduced to the bottom of the thread, the latter portion not being able to get beyond the worm wheel, which carries a key for driving *B*.

The back end of the sleeve on the worm wheel *E* has four notches, and carries a loose strap *M*, while *N* is the trigger for indexing the division plate. *S* is the chuck for gripping the work, which passes into the hollow screw former. There are four bolt slots *Y* for securing the fixture to the milling-machine table, these being preferable to the two usual lugs, as the fixture has to be set at an angle, and not parallel with the tee-slots, as is generally the case.



FIXTURE FOR CUTTING QUADRUPLE THREAD

How It Operates

To operate the fixture, the work shown in the plan is secured in the chuck, the screw *B* being turned full into the nut *C*. The worm *F* is then brought into mesh with the worm wheel *E*. A handle is then put on the square end of the worm spindle *K*, and when four turns of the worm are completed *E* will have made one revolution, and carried *B* with it, the feather key sliding in the keyway *L*. The fixture is set at the proper angle on the milling-machine table, to suit the diameter of the work in hand, and the cutter set central. A thread will then be produced in the work, having the same lead as the master screw *B*, when the latter is fed through the nut *C*.

When one thread is completed the strap *M* should be tightened on the split end of *E*, which in turn grips *B*, and thereby secures the screw and worm wheel together. The bracket which carries the worm is then swung back, and the trigger drawn out of the dividing plate, the latter turned one-quarter revolution to the next notch. Let it be noted that the worm wheel and screw have turned one-quarter revolution *without the latter moving forward*. The worm *F* is then brought into gear with *E*, and the strap *M* slackened, when all is ready for proceeding as before, to cut the next thread until the screw is completed.

Owing to the quick pitch of the thread, and stock to be removed, we found that we could not do without the worm wheel being interposed, as we got a very rough and jagged thread with the handle on the back end of screw *B*, besides the attendant danger of the cutter revolving and spoiling the work if the operator released the handle, whereas the worm wheel acts as a safeguard and prevents the work from being dragged by the cutter.

With this fixture we found that an intelligent boy could complete 40 screws per day.

"Swift England."

Cutting Quadruple Threads

In a shop where I was recently employed I happened to notice a fellow workman cutting a quadruple screw, cutting all the threads simultaneously.

Fig. 2 *A* is the forged body in which the slot is milled to receive cutter *B*, which is made with proper rake to clear the thread on the front edge of the cutters and angled at the back the same degree as the wedge. A hole is drilled through an easy fit for the bolt *D*. The wedge *C* keeps the cutter square and solid. The bolt *D* goes right through both body and tool, clamping with the nut.

The tool was used with great success. The screws were made in pairs. I do not remember the dimensions, but should say about 2½ inches diameter by 8 inches long on the threaded part. Fig. 1 shows the work; of course, the tool ran across and clear of the work. After the screw was cut to size it was parted through the middle, leaving two 4-start screws cut just under 40 minutes, which certainly is "going some."

B. P.

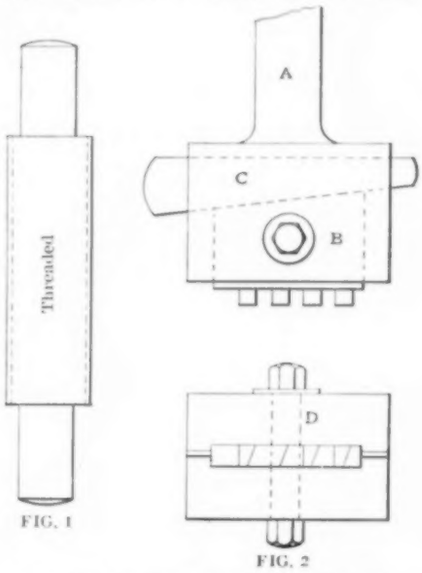


FIG. 1 FIG. 2

TOOL FOR CUTTING QUADRUPLE THREADS

The Element of Time

Some people never let pass an opportunity to give the technical graduate a rap, and hereby hangs the tale, "Horse-power vs. Mare Power," at page 627.

If Mr. Brick had stated that he had about six months in which to move a few cubic yards of dirt, probably the youthful engineer could have given him a common-sense answer. If we consider such propositions, it is natural to suppose that it is for a "going" concern, and the object is to perform the work in the shortest possible, rather than the longest possible time.

Mr. Brick might exchange his old mare for a couple of "billies," and do the work just the same.

Ga. Tech.

An Antique Weighing Machine

The accompanying sketches show an old-time weighing balance, picked up in Flanders, Belgium. It was purchased from a lady 94 years of age, who said that it originally belonged to her grandmother; so its antiquity is beyond question.

Such balances were in common use during the eighteenth and early nineteenth centuries, for weighing flax principally. The flax industry was a flourishing one in Flanders, and the country and village dames spun the flax on the spinning wheel before weaving it into cloth on their hand looms. The flax was carefully weighed before spinning, hence the necessity of a weighing balance in every household.

Fig. 1 gives a side view of the balance.

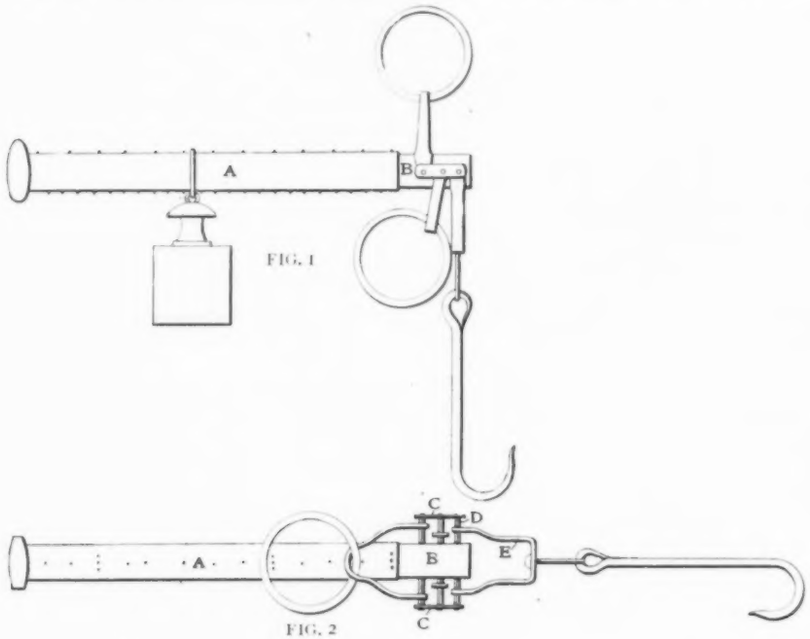


FIG. 1

FIG. 2

AN ANTIQUE WOODEN STEELYARD

The lever on which the weight is suspended is made of hard wood, with brass nails driven into it top and bottom, those on top being wider spaced than the bottom ones. The use of these nails will be explained presently.

On one end of the wood lever *A* a brass socket or ferrule *B* is secured, carrying the complete mechanism of the balance. As will be seen by Fig. 2—which is a plan of the balance—the brass socket *B* carries three small pivot bars at each side, each bar being in line with the corresponding bar on the opposite side. These pivot bars are made of iron, and were originally knife-edged top and bottom. Their centers are ⅜ inch apart, and they are held rigidly in place by means of two brass plates *C*, one at each side, through which they are riveted.

On the pivot bar *D* at the outer end of the brass socket is attached the hook for holding the flax, by means of a U-shaped hanger *E*, Fig. 2. This hanger has two holes so that it can swing easily on the bar. On the other two bars are corresponding hangers with rings, which were used for hanging up the balance on any convenient nail or hook.

When the balance was in use, as shown in Fig. 1, the distance between the last bar—from which the hook is suspended—and the fulcrum, which in this case is the first bar, is ¾ inch. The balance in this position was used for weighing light weights. The brass nails, shown by dots on top of the lever, were used for marking off the pounds, ounces, etc., of goods being weighed. The weight was moved along the lever from the brass socket to the outer end, the same as in an up-to-date weighing machine. It has been much used in this position, as the wood between the nails is considerably hollowed out by the friction of the ring which carries the weight.

By turning the balance upside down, and hanging it up by the ring which is shown hanging down in Fig. 1, a much heavier article can be weighed, as the distance between the fulcrum and hook hanger is now only ⅜ inch. The brass nails now shown on top are naturally much closer spaced. It has evidently been but little used for the heavier weights, as there is no indication of the wood being worn below the level of the nails on this side. The wood arm is ¾ inch diameter and its total length is 10 inches.

D. G.

[One peculiar thing about this *wooden* steelyard is that the weight used is a *half kilo* and the divisions on the arm are by *sixths*, not by *tenths*, as one would naturally expect, coming as it does from a "metric" country.—Ed.]

High-speeds Steel in the General Shop

I have read "English Machinist's" article on page 697 and am inclined to think that either he has been swindled in the steel he used, or else he does not know how to harden it properly. I am a great advocate of high-speed steel, and there is hardly a day passes that I do not gain some advantage from its use.

"English Machinist" says that the aim of every shop is to make as little scrap as possible. This is true enough in a way, but let me mention a few cases where it is cheaper to make scrap in the way of chips, manufacturing articles from the bar, than to make them from forgings and have little scrap.

Take, for example, spindles of engine lathes about 2¾ inches in diameter, with a flange 3¾ inches in diameter at one end. I tried to make them from forgings and was always having trouble from different causes. Sometimes the scale on the forgings would be so hard that it would require three tools to finish one cut. Again the forgings would come all shapes: some round, others nearly square; some with only ⅛ inch left for machining, others with ½ inch or more. The ends were often so ragged that I had to chuck the forgings in a lathe and square the ends before I could center them.

I tried making them from the bar and have been highly satisfied with the results. The stock was 4-inch bars, and with the use of high-speed steel it was soon reduced to 2¾ inches in diameter, leaving the flange 3¾ inches in diameter. The machining took but little longer than with the forgings. Altogether, I figured that we saved fully 10 per cent. on the total cost of their manufacture.

We could get our bars out of stock, whereas we often had to wait a month or six weeks for forgings. Then, in boring out the spindles (to 1¾ inches in diameter) it is obvious that a lot of metal has to be cut away as scrap. This is a necessary evil, and the use of high-speed steel is bound to save time. I could mention many cases where it is cheaper to make things from the bar, hogging off the surplus stock, than it is to use forgings.

"English Machinist" will say: "How about light cuts?" Even here a saving can be effected, as I will illustrate. Some time ago I had a quantity of shafts to turn up. They were 2 inches in diameter and 10 feet long. There was only 1/16 inch to take off, so I set two tools (high-speed steel) so that each would have 1/32 inch of the cut. One was set ahead of the follower rest and the other behind. The shafts were run at 250 revolutions per minute, which is about 125 feet per minute cutting speed. The feed of the tools was 1/32 inch. With a good supply of suds these tools would do a shaft without grinding or stoning.

I could mention other cases where time could be gained on light cuts. Armstrong, Whitworth & Co., Manchester, England, even go so far as to make high-speed steel razors, claiming that shaving can be done quicker and cleaner with this high-speed steel than with any other.

I think "English Machinist" should try again and see if he cannot get better results from the use of high-speed steel. It is an important point in hardening this steel to get it very hot. Some makers specify the heat required as *white heat.* It is impossible to get the tools hard unless this is done. CONRAD.

Annealing High-speed Steel

High-speed steel, from one point of view, is both a soul-destroying and a file-destroying material; and the annealing of it maketh the heart sick. While your contributor E. V., page 534, considers that the whole secret lies in getting the steel to a great heat and allowing it to cool slowly, I have found the first proceeding entirely unsuccessful. I have taken two pieces of the same bar, a bar that was originally on the soft side, heated one piece to a high heat and the other to just a bright red, keeping them buried in the forge fire, which was allowed to die out. I have found the superheated piece to be as hard as if quenched, and the lesser-heated piece to be nicely workable.

Nor is it necessary, as in the common practice, to keep the steel cooling after the glow has subsided; for at any heat lower than a red, immediate quenching has no practical effect upon the temper. Much time might be saved with the recognition of this point.

Also I have not found his principles of hardening to work. Nothing short of white heat will, in my experience, satisfactorily harden high-speed steel; and the softer bars referred to require to be heated something just short of the danger point, which naturally blisters the steel badly. 'Tis certain too, and this point needs emphasis, that high-speed steel, to do its work, *must* be hard. There appears to be no intermediate stages of "just hard enough;" what is not hard is no good for anything. ALLOY.

Distortion of Steel in Hardening

On page 494 is an article entitled "A Gang Die for Making a Ferrule," in which the writer says that in planing the blanks they were left wider than the finished size to allow for contraction in hardening. It would have been more instructive had the writer been specific in giving figures and amount of allowance together with the result after hardening.

On page 495 appears an article headed "Fitting a Hardened and Threaded Plug." The writer said that in making the plug, which was 2½ inches in diameter, he allowed 0.0003 inch for swelling of the steel in hardening, as that seemed to be about the amount that particular brand of steel needed. He neglected, however, to give the brand of steel, but intimated that after allowing 0.0003 inch for swelling in hardening the plug was still too large.

I consider this statement to be simply ridiculous and misleading, especially to beginners, as there is no steel that will expand in hardening. I will not question the assertion that he had some trouble in fitting the plug, but I think it was due entirely to distortion. The method employed to remedy the defect was probably as good as could be adopted, but a chaser make of iron or soft steel would have answered the purpose fully as well as one made of brass. J. H. MADIGAN.

A Table of Dimensions for Miter Gears

The accompanying table is of service in determining the principal dimensions of miter gears (center angle 45 degrees), the number of teeth and the pitch being known. The table covers most of the possible numbers of teeth from 12 to 60, inclusive, and pitches from 2 to 10, inclusive, omitting 9.

The arrangement and use of the table needs no explanation.

WM. G. THUMM.

MITER GEARS, CENTER ANGLE 45 DEGREES.

No. of Teeth	Pitch Diameters.								Outside Diameters.								Face Angle.	Cut Angle.
	2 P.	3 P.	4 P.	5 P.	6 P.	7 P.	8 P.	10 P.	2 P.	3 P.	4 P.	5 P.	6 P.	7 P.	8 P.	10 P.		
12	6	4	3	2⅖	2	1⅞	1½	1⅕	6.71	4.48	3.35	2.68	2.24	1.92	1.68	1.34	51° 43′	38° 17′
13	6½	4⅓	3¼	2⅗	2⅙	1⅞	1⅝	1⅓	7.21	4.80	3.60	2.88	2.40	2.06	1.81	1.44	51° 12′	38° 48′
14	7	4⅔	3½	2⅘	2⅓	2	1¾	1⅖	7.71	5.14	3.85	3.08	2.57	2.20	1.93	1.54	50° 47′	39° 13′
15	7½	5	3¾	3	2½	2⅛	1⅞	1½	8.21	5.46	4.10	3.28	2.73	2.35	2.06	1.64	50° 23′	39° 37′
16	8	5⅓	4	3⅕	2⅔	2⅜	2	1⅗	8.71	5.80	4.35	3.48	2.90	2.49	2.18	1.74	50° 03′	39° 57′
17	8½	5⅔	4¼	3⅖	2⅚	2⅜	2⅛	1⅗	9.21	6.14	4.60	3.68	3.07	2.63	2.31	1.84	49° 45′	40° 15′
18	9	6	4½	3⅗	3	2⅝	2¼	1⅘	9.71	6.48	4.85	3.88	3.24	2.77	2.43	1.94	49° 29′	40° 31′
19	9½	6⅓	4¾	3⅘	3⅙	2¾	2⅜	1⅞	10.21	6.80	5.10	4.08	3.40	2.92	2.56	2.04	49° 15′	40° 45′
20	10	6⅔	5	4	3⅓	2⅞	2½	2	10.71	7.14	5.35	4.28	3.57	3.06	2.68	2.14	49° 03′	40° 57′
21	10½	7	5¼	4⅕	3½	3	2⅝	2⅒	11.21	7.46	5.60	4.48	3.73	3.20	2.81	2.24	48° 51′	41° 09′
22	11	7⅓	5½	4⅖	3⅔	3⅛	2¾	2⅕	11.71	7.80	5.85	4.68	3.90	3.35	2.93	2.34	48° 41′	41° 19′
23	11½	7⅔	5¾	4⅗	3⅚	3⅜	2⅞	2⅒	12.21	8.14	6.10	4.88	4.07	3.49	3.06	2.44	48° 31′	41° 29′
24	12	8	6	4⅘	4	3⅜	3	2⅖	12.71	8.48	6.35	5.08	4.24	3.63	3.18	2.54	48° 22′	41° 38′
25	12½	8⅓	6¼	5	4⅙	3½	3⅛	2½	13.21	8.80	6.60	5.28	4.40	3.77	3.31	2.64	48° 14′	41° 46′
26	13	8⅔	6½	5⅕	4⅓	3⅝	3¼	2⅗	13.71	9.14	6.85	5.48	4.57	3.92	3.43	2.74	48° 07′	41° 53′
27	13½	9	6¾	5⅖	4½	3⅞	3⅜	2⅗	14.21	9.46	7.10	5.68	4.73	4.06	3.56	2.84	48° 00′	42° 00′
28	14	9⅓	7	5⅗	4⅔	4	3½	2⅘	14.71	9.80	7.35	5.88	4.90	4.20	3.68	2.94	47° 54′	42° 06′
29	14½	9⅔	7¼	5⅘	4⅚	4¼	3⅝	2⅞	15.21	10.14	7.60	6.08	5.07	4.35	3.81	3.04	47° 47′	42° 13′
30	15	10	7½	6	5	4⅜	3¾	3	15.71	10.48	7.85	6.28	5.24	4.49	3.93	3.14	47° 42′	42° 18′
31	15½	10⅓	7¾	6⅕	5⅙	4⅝	3⅞	3⅒	16.21	10.80	8.10	6.48	5.40	4.63	4.06	3.24	47° 37′	42° 23′
32	16	10⅔	8	6⅖	5⅓	4⅝	4	3⅕	16.71	11.14	8.35	6.68	5.57	4.77	4.18	3.34	47° 32′	42° 28′
33	16½	11	8¼	6⅗	5½	4⅘	4⅛	3⅓	17.21	11.46	8.60	6.88	5.73	4.92	4.31	3.44	47° 27′	42° 33′
34	17	11⅓	8½	6⅘	5⅔	4⅞	4¼	3⅖	17.71	11.80	8.85	7.08	5.90	5.06	4.43	3.54	47° 23′	42° 37′
35	17½	11⅔	8¾	7	5⅚	5	4⅜	3½	18.21	12.14	9.10	7.28	6.07	5.20	4.56	3.64	47° 19′	42° 41′
36	18	12	9	7⅕	6	5⅛	4½	3⅗	18.71	12.48	9.35	7.48	6.24	5.35	4.68	3.74	47° 15′	42° 45′
37	18½	12⅓	9¼	7⅖	6⅙	5⅜	4⅝	3⅘	19.21	12.80	9.60	7.68	6.40	5.49	4.81	3.84	47° 11′	42° 49′
38	19	12⅔	9½	7⅗	6⅓	5⅝	4¾	3⅞	19.71	13.14	9.85	7.88	6.57	5.63	4.93	3.94	47° 08′	42° 52′
40	20	13⅓	10	8	6⅔	5⅞	5	4	20.71	13.80	10.35	8.28	6.90	5.92	5.18	4.14	47° 01′	42° 59′
42	21	14	10½	8⅖	7	6	5¼	4⅕	21.71	14.48	10.85	8.68	7.24	6.20	5.43	4.34	46° 56′	43° 04′
44	22	14⅔	11	8⅘	7⅓	6⅜	5½	4⅖	22.71	15.14	11.35	9.08	7.57	6.49	5.68	4.54	46° 50′	43° 10′
46	23	15⅓	11½	9⅕	7⅔	6⅝	5¾	4⅗	23.71	15.80	11.85	9.48	7.90	6.77	5.93	4.74	46° 46′	43° 14′
48	24	16	12	9⅗	8	6⅞	6	4⅘	24.71	16.48	12.35	9.88	8.24	7.06	6.18	4.94	46° 42′	43° 18′
50	25	16⅔	12½	10	8⅓	7⅛	6¼	5	25.71	17.14	12.85	10.28	8.57	7.35	6.43	5.14	46° 37′	43° 23′
54	27	18	13½	10⅘	9	7⅞	6¾	5⅖	27.71	18.48	13.85	11.08	9.24	7.92	6.93	5.54	46° 31′	43° 29′
58	29	19⅓	14½	11⅗	9⅔	8⅜	7¼	5⅘	29.71	19.80	14.85	11.88	9.90	8.49	7.43	5.94	46° 24′	43° 36′
60	30	20	15	12	10	8⅝	7½	6	30.71	20.48	15.35	12.28	10.24	8.77	7.68	6.14	46° 21′	43° 39′

A TABLE OF DIMENSIONS FOR MITER GEARS.

Experiments with alloys of many kinds seem to be the order of the day. This includes not only the various alloy steels, but also alloys of iron with copper and the softer metals, although these have not been highly successful as yet.

The rise in the price of platinum is one of the phenomenal features of the advance in the values of metals in the past two years. The Ural District of Russia is the source of nearly 90 per cent. of the supply. In 1906 platinum reached a price five times that of 1890.

AMERICAN MACHINIST

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The Taylor Bonus System of Paying for Labor

The large amount of attention which the Taylor bonus system of paying for labor is now receiving justifies some remarks about its fundamental principles. The payment for labor is of course but a single feature of Mr. Taylor's elaborate system of shop management; but nevertheless it may, we think, be considered the crux of the entire system, since it is to this that the entire scheme of time study, the study of the performance of tools and the methods of shop organization are directed. All of these things are of course intended to increase output, and they all finally center upon the workman who is to carry out the directions given and be rewarded in accordance with the results.

The Taylor system differs from the premium plan essentially in that the former undertakes an elaborate study of the work by experts, as a result of which the workman is finally given minute instructions about every feature of his work, with almost no opportunity for initiative of his own, while under the latter this initiative on the part of the workman is the chief reliance, he being told to follow his own devices and to expect increased wages in accordance with the results which he obtains. The elaborate nature of the Taylor system makes it easy to overlook its essential principle, and the first thing to do when attempting to analyze it is to ignore its elaborate features and direct the attention to this fundamental principle.

It seems to us that this fundamental principle is essentially wrong. Suppose a machine-shop foreman were to find a lathesman running a lathe with too slow a feed and should say to him: "That job will stand such and such a feed; put on such a feed, and you will increase the output to such and such a figure, and when you have done so, if my estimate proves to be correct, I will raise your wages." Such a procedure would be absurd enough, and yet it is precisely what the management does on a wholesale scale when it introduces the Taylor system. It gives every workman complete instructions regarding every detail of his work—the feed, depth of cut, speed, shape of tool, etc.—in order to produce a certain output, which has been estimated in advance, and it then in effect says to him: "If you will produce this output," that is to say, "if our estimate of the results to follow the instructions proves to be correct, we will increase your wages." If, on the other hand, the workman fails to produce the results, that is, if the estimate which results from all of the elaborate time study and reorganization of the shop proves to be too high, then the workman gets no increase. On the other hand, should the workman find the estimate too low, and be able to increase the output beyond that estimated by his own knowledge or efforts, he gets nothing for the exercise of his own initiative. The increase is paid if the estimated output is reached, no bonus being paid if the results fall short by ever so small an amount, and nothing beyond the fixed bonus if the estimate is exceeded.

To look at the matter still more briefly, the workman is given the most specific instructions what to do, and is then rewarded by an increase of wages for simply obeying orders.

The case is, however, still worse than this, because the estimated output is the result of a preliminary study which has cost a large sum of money. This being the case, the management is entitled to all of the results which can be obtained from this study, and, under the Taylor system, after paying for these results once through the cost of the preliminary study, the management is called upon to pay for them again in increased wages to the workman.

We can see neither rhyme nor reason in the philosophy of such a system. Under the premium plan, the increased payments to the workman are justified. The increased output under that system is due to the use of the wit, the energy and the knowledge of the workman. The increased output is the direct result of the incentive placed before the workman to increase his efforts and follows from the exercise of his own initiative. Without the incentive the results would not have been obtained, and payment for them through increased wages is perfectly logical. We are not, however, able to see any justification whatever for increased wages for the increased output which results from the simple following of the plainest directions under the Taylor system.

Practical and Cultural Training in Technical Schools

Our columns have contained many articles about the technical schools; some condemning their methods, some condemning their results and only a few in defense. The general impression left after such reading is, that the writers have found in some technical graduates a woeful lack of practicability and that such practical training can be obtained only by actual contact with the machine shop. We are pleased to call attention to two articles in this week's issue describing shop training in connection with an engineering course. We refer to "Shop Practice in the Engineering Course of the University of Cincinnati," by Mr. Manley, and "Shop Management," by Professor Bird, of the Worcester Polytechnic Institute. While in the courses of each school practical shop training is an important element, their methods are entirely different. In Cincinnati the students get the shop training in the shops and factories of the

city amid actual making conditions. In Worcester the students work in the shops connected with the Institute. These shops, however, are run on a commercial basis aside from the feature of affording instruction.

It is not our purpose to draw comparisons between these two methods, but to point out the element of practical training which these schools have in their engineering courses, in contrast with the often expressed idea that all technical training is theoretical and experimental. One of the best features is the elimination of some students who are not fitted for an engineering life by bringing them into actual contact with shop realities early in their course.

We would be the last to say a word against this practical training for the engineering students, yet we hope that the temptations of the path of least resistance will not influence any of our great institutions for technical education to lower their standard of broad culture. The spirit of commercialism says, practical and specific training. May this not be allowed to lessen the amount or quality of the instruction in the humanities!

The habit of mind of the average engineering student is masculine—we started to say *distinctly masculine*—in that it tends toward mathematics and construction. Yet these qualities of mind and training can be made of more real use to their possessor if he has with it all a broad foundation of academic culture.

A single illustration will suffice. Technical literature as a whole is severely criticized for lack of elegance, and at times this criticism is carried further and the statement is made that technical writers exhibit a paucity of vocabulary and a lack of knowledge of the elements of clearness and force.

While the character of the subjects is perhaps a reason to some extent for the facts causing the first two criticisms, the last two cannot be thus explained. Our technical literature has a real place among the records of the world and should be in a form worthy of its position. We must look to the technically trained man in a large measure for its production, and this is one reason why meeting the demand for practical training should not be allowed to lower the standard of broad cultural training for the technical student.

John A. Walker

John A. Walker, vice-president and treasurer of the Joseph Dixon Crucible Company, died at his home, Jersey City, N. J., on May 23. Mr. Walker was born in the city of New York, September 22, 1837. He received his early education in the schools of Brooklyn, and, although prepared for college in a private school, chose commercial life. After an excellent business training in the city of New York, and after serving his country in the civil war of the South, Mr. Walker, in 1867, became connected with the firm of Joseph Dixon & Co., of Jersey City. In 1868, when Joseph Dixon & Co. became incorporated as the Joseph Dixon Crucible Company he was made secretary of that company, and began his lifework in making known to the world the many uses of the then but little known form of carbon—graphite.

Mr. Walker served the Dixon company as secretary and largely as manager until 1891, when he was unanimously elected to the dual position of vice-president and treasurer, the latter office having been held by him for some time previous.

As vice-president and treasurer of the Joseph Dixon Crucible Company there was more than work enough for any ordinary man, yet, outside of his duties as such we find him vice-president Colonial Life Insurance Company, director New Jersey Title Guarantee and Trust Company, director Pavonia Trust Company, director the Provident Institution for Savings, president the Children's Friend Society, all of Jersey City; trustee the Stationers' Board of Trade of New York. He had served as first vice-president of the National Stationers' and Manufacturers' Association. He was member of the Chamber of Commerce of New York, and of the Board of Trade of Jersey City. He was chairman of the executive committee of the Cosmos Club, of Jersey City, member of the Carteret Club, the Union League Club, the Lincoln Association, all of Jersey City, member of the National Geographic Society, and associate member of the American Institute of Mining Engineers, and of the Society for Psychical Research.

In the years gone by Mr. Walker has actively and successfully served as member of the Jersey City Board of Education; as trustee of the Jersey City Public Library and of other city institutions. Mr. Walker leaves a widow only.

New Publications

OPEN-HEARTH STEEL CASTINGS. By W. M. Carr. 118 5¼x7½-inch pages; 19 illustrations. The Penton Publishing Company, Cleveland, O. Price, $1.50.

This little book is a compilation of a series of articles written by the author for trade papers, and explains the methods used in both the basic and acid processes of making open-hearth steel. It gives a variety of information on materials used, fuels and alloys, furnace construction, methods of charging, melting, chemical and physical tests, blow holes and cracks in steel castings, heat treatment and annealing, repairing with thermit, and the cost of equipping open-hearth steel foundries. The illustrations give definite information as to dimensions, show arrangement of furnaces, graphical records of tests and sections of bars under varied conditions. It should prove useful to the many who are interested in this line.

THE 20TH CENTURY TOOLSMITH AND STEELWORKER. By H. Holford. 240 5x7½-inch pages, 117 illustrations. Frederick J. Drake & Co., Chicago, Ill. Price, $1.50.

This contains many practical hints for the blacksmith and tool dresser who has to make cold chisels, tongs, stonecutters' tools, and the like, and as there is very little in print along these lines, it should be welcomed by many. But when it comes to being a guide for the twentieth century steelworker, assuming this to mean the annealing, hardening and tempering of taps, dies and other tools, it falls far short of the mark and cannot be compared with other books on this subject. We should place greater dependence on this part of the book if it had omitted the rather pretentious color chart as a guide to hardening and tempering, or had even given it as a suggestion for painting bars of different grades in stock. The subject of hardening and tempering alone would make a book several times as large as this, and we regret that the author attempted to cover so much ground in one small volume.

THE OPERATION, CARE AND REPAIR OF AUTOMOBILES. By Albert L. Clough. 343 6x9-inch pages; 158 illustrations. The *Horseless Age*, New York.

This is a collection of information for users and repairers of automobiles selected from articles which have appeared in the *Horseless Age* from time to time and giving the experience of various men under different conditions. It seems to take up about all phases of automobile running and repairs, from the electric sparking apparatus to tires, with such important questions as the storage and handling of gasolene and heating and ventilating garages in between. Instead of taking up special makes of cars in detail it goes into general principles and seems to contain more real information that should be useful to all who are interested than is often found in a book. The type is rather smaller than usual in books but as this means more information for the reader he is not likely to object. The illustrations show many practical ideas that will be particularly useful to repair men and the book should be welcomed by automobile mechanics generally.

Pig-iron production during the month of April was 2,216,558 gross tons, an increase of almost 7 per cent. over that for the corresponding month of 1906, and for the first four months of the year aggregated 8,692,408 gross tons, or about 6 per cent. in excess of that for the corresponding period of 1906.

New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

The "Economic" Drafting Rig

In this drafting arrangement the ruling blade is carried at each end by a stiff swing and rock shaft supported in an iron framework about 30 to 36 inches above the drawing board. The weight of the swing is taken by long coiled springs, at the back of the frame, which at the same time permit the blade to be lifted several inches above the drawing board to accommodate changes of drawings or boards, or the swing may be turned entirely out of the way above the frame work. A tie rod and wooden finger bar extend the length of the blade, distributing the slight excess weight of the swing first to the mid-length of the bar and thence to the ends of the blade in a way to accommodate any ordinary unevenness in the drawing board. The effect is to supply a compact arrangement for horizontal ruling that is easy of manipulation and stable in any position.

It also permits the use of a light, easily handled tool for vertical lining, with an advantage over the constant use of a long or cumbersome ruler for the sake of the occasional long line, as both horizontal and vertical rulers are easily controlled by one hand together or separately and without regard to the condition of the drawing board as to straight edges, flat surface or level position, within reasonable limits.

The shelf at the upper part of the frame affords a convenient place for tools, books and papers and often a handy place from which to suspend tracings or sketches that are being copied. At each end of the drawing board is a receptacle for a coil of tracing cloth that may extend beyond the limits of a drawing.

The views also show a recent form of the universal square (by the same maker) with graduated scales on the inner ruling edges. The central tongue has the regular 30-degree and 60-degree angles for bolt heads and swings through 120 degrees as read from a vernier and graduated arc on the metal plate that holds the arms of the square together. As the square is turned with opposite arms against the ruling blade the tongue supplies ruling edges perpendicular to each other. The whole instrument is controlled by a knob and saves much interchange of triangles, protractor plates and scales.

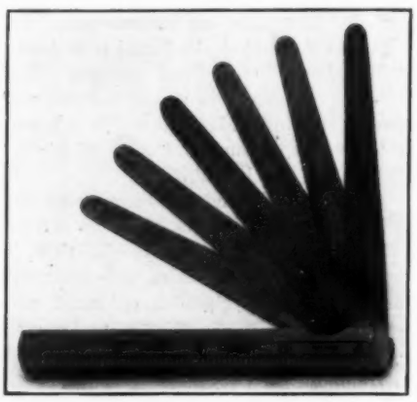
The drafting rig may be made in special sizes when required but the usual sizes are for 23x31 and 31x42-inch boards. Duane J. Kelsey, 77 Livingston street, New Haven, Conn., is the manufacturer.

Thickness Gage or Feeler

Probably every machinist who has ever done fitting of any kind has used paper or sheet metal to feel the contact or lack of contact between two surfaces, in other words to measure or detect slight distances between them.

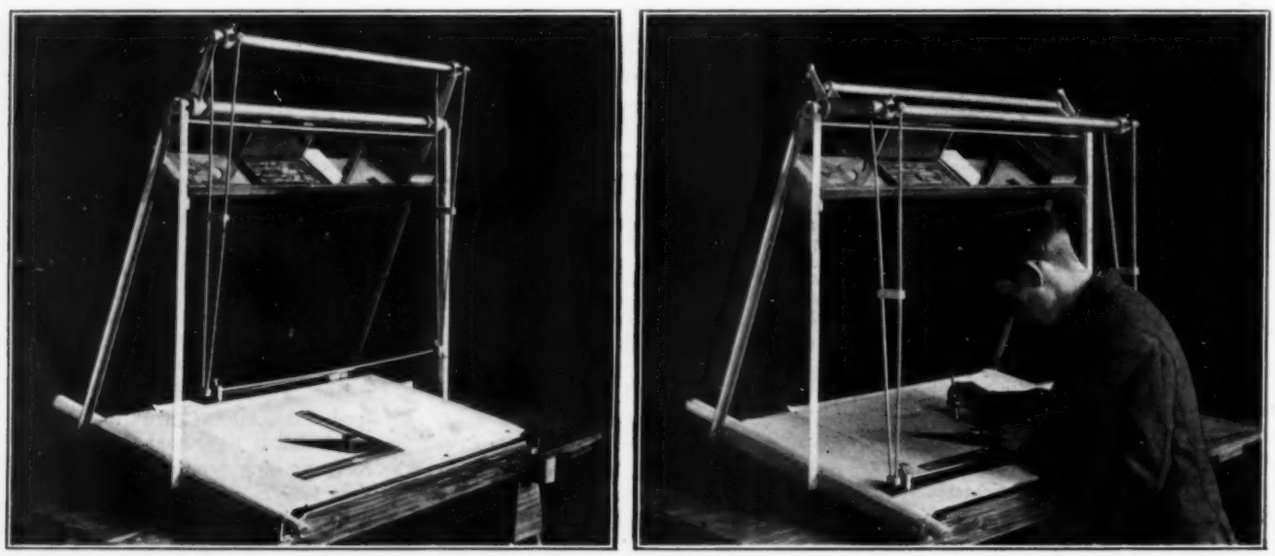
While much fine work has been accomplished in this way, it is after all a matter of fine guess-work and no practical man will doubt the value of such a feeling gage as is illustrated with this article, where the blades are a definite thickness so that you know just what allowance is being made in each case.

With such a tool you can run the lathe carriage to within any desired distance, say 0.015 inch of the carriage stop, and this gives you the same allowance for a finishing cut every time. Or in measuring for a hole to give a certain allowance over the shaft that is to run in it, you can caliper over the shaft and the desired leaf of the feeler together.



THICKNESS GAGE OR FEELERS

There are many other applications which come up from time to time so that its uses will be self evident to all; while the idea is not entirely new, this de-



THE "ECONOMIC" DRAFTING RIG

vice is put up very neatly, the case or handle being a 4-inch scale on both sides; one side divided inches to 16ths, the other inches to 10ths, 20ths and 50ths. It bears the trademark of Chesterman, and is sold in this country by Wiebusch & Hilger, Ltd., New York.

Obituary

Hermon Miller, superintendent can-making plant of the Standard Oil Company, Devoe works, Long Island City, died June 3. Mr. Miller was identified with can-making machinery all of his active life and originated many improvements in this line of work.

Business Items

The Buffalo Forge Company has changed its Pittsburg office from 1101 Diamond Bank Building to 613 House Building. E. P. Leadbetter, manager.

The F. W. Spacke Machine Company, Indianapolis, Ind., has just completed a two-story addition to its factory, which will about double its capacity.

The Dayton Machine and Tool Works, Dayton, O., is now moving into its new factory, where it will be in a better position to meet the demand for its grinders.

Dodge & Day, Drexel Bldg., Philadelphia, Penn., have opened an office in the United States Realty Bldg., 111 Broadway, New York. Robt. T. Lozier is in charge.

The Bullard Machine Tool Company, Bridgeport, Conn., is exhibiting one of its boring mills at the M. M. and M. C. B. convention, June 12 to 19, at Atlantic City.

The General Pneumatic Tool Company, represented by W. A. Battey, has taken larger offices in the Singer Building, New York, and is now located in suite No. 915.

The Heywood Bros. & Wakefield Company has placed a contract with Frank B. Gilbreth, New York, for the erection of a modern factory at a cost of $300,000 at Gardner, Mass.

The Pittsburg (Penn.) Automatic Vise and Tool Company, has placed its St. Louis, Mo., business in the hands of the Southwestern Engineering and Supply Company, of that city.

The Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, is exhibiting one of its motor-driven lathes at the M. M. and M. C. B. convention at Atlantic City, N. J., June 12 to 19.

The new foundry of the American Hoist and Derrick Company, St. Paul, Minn., is to be heated by the blower system which will be installed by the B. F. Sturtevant Company, of Boston, Mass.

The American File Sharpener Company, New York, informs us that it will have one of its file-sharpening machines in operation at the M. C. B. Convention, to be held at Atlantic City, June 12 to 19.

We have been informed by the Hagan Gas Engine and Manufacturing Company, Winchester, Ky., that there is a good opening in that place for a foundry, there being none within a radius of one hundred miles.

The Independent Pneumatic Tool Company, Chicago, Ill., has a complete working exhibit of its pneumatic tools and appliances at the M. M. and M. C. B. convention at Atlantic City, N. J., June 12 to 19.

At a special meeting of the directors of the Joseph Dixon Crucible Company, held May 31, to take action on the death of vice-president and treasurer John A. Walker, George T. Smith was elected vice-president, George E Long treasurer, and Harry Dailey was elected director and secretary.

The Sprague Electric Company, of New York City, has opened a district office in the Hennen Building, New Orleans. This office is under the management of F. V. L. Smith, lately chief inspector of the Louisiana Bureau of Fire Prevention, and will cover the territory included in the States of South Carolina, Florida, Alabama, Georgia, Tennessee, Mississippi, Louisiana, Arkansas, Texas, Oklahoma and Indian Territory.

The Boston Gear Works, of Norfolk Downs, Mass., are erecting a large addition to their new works, which will increase their facilities 50 per cent.; their present plant covering 22,000 square feet and when this new addition is completed, they will have 33,000 square feet of floor space. These increased facilities will enable them to handle any kind of work, both large and small, and the increased capacity will enable them to fill orders promptly.

Trade Catalogs

Buffalo Forge Company, Buffalo, N. Y. Folder illustrating and describing disk wheels.

B. P. Fortin Tool Co., Woonsocket, R. I. Catalog describing universal jigs. Illustrated, 8 pages, 3½x6 inches, paper.

United Engineering and Foundry Company, Pittsburg, Penn. Pamphlet illustrating new machinery for iron, steel and tube works. 24 pages, 4x9 inches, paper.

Goldschmidt Thermit Co., 90 West St., New York. Pamphlet describing fire brick molds for welding locomotive frames by the thermit process. Illustrated, 12 pages, 6x9 inches, paper.

James L. Taylor Manufacturing Company, Bloomfield, N. J. Catalog No 8, with price list of quick-adjusting self-locking screw clamps. Illustrated, 24 pages, 3½x6 inches, paper.

Westinghouse Electric and Manufacturing Company, Pittsburg, Penn. Pamphlet, industrial Series No. 13101, describing electrical equipment at the Hornell shops of the Erie Railroad. Illustrated, 24 pages, 6x9 inches, paper.

The Scientific Shop, Albert B. Porter, 324 Dearborn street, Chicago, Ill. Catalog D of optical parts, including test planes, plane parallels, telescopic objectives, eyepieces, lenses, prisms, etc. Illustrated, 48 pages, 6x9 inches, paper.

Manufacturers

The Hamilton (Ohio) Foundry and Machine Company will erect an addition.

The Moon Desk Company, Muskegon, Mich., will erect a four-story addition.

The Holscher Electrical Manufacturing Company, Warren, Ohio, will erect a new plant.

The Buckeye Pump and Manufacturing Company, Columbus, Ohio, will erect a new plant.

The Hamilton (Ohio) Autographic Register Company, will erect an addition to its plant.

A new factory is being built for the Frankford Gas Fixture Company, Philadelphia, Penn.

An addition will be built to the plant of the A. Carpenter & Sons Foundry Company, Providence, R. I.

A model power plant is to be put up by the Union Stock Yards and Transit Company, Chicago, Ill.

A new foundry and blacksmith shop are being added to the plant of the Greenlee Bros., Rockford, Ill.

E. H. Smith, Salt Lake City, Utah, is building a large foundry at Sixth West and Fifth South streets.

The Jacksonville (Fla.) Iron Works Company has been incorporated with $25,000 capital. B. G. Lasseter, president.

Hoopes Bros., Manufacturing Company, Adel, Iowa, will move to Des Moines, where they will manufacture small hardware lines.

The Royal Typewriter Company, of Bay Ridge, N. Y., will move to Hartford, Conn., where a $500,000 plant will be erected.

The Imperial Wheel Company, of Flint, Mich., will, it is reported, establish a plant near Pine Bluff, Ark., investing $30,000.

The Multnomah Mechanical Manufacturing Company, Portland, Ore., makers of farm traction machinery, will move to Hamilton, Ohio.

L. K. Flannagan, of Unionville, Mo., is taking steps to organize a company in Des Moines, Ia., to manufacture smoke consumers.

The Texas Central Railroad, it is reported, will erect roundhouse and machine shops at Asco. H. S. McCall, Waco, Texas, resident engineer.

The Western Fire Brick Company has been incorporated at Denver, Colo., and has purchased site for a plant. William Geddis is president.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

We desire a few more machines or specialties to manufacture. Address Box 423, Troy, N. Y.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

C. W. Clifford, M. E., working and patent drawings and tracings. 643 N. 44th St., Philadelphia, Pa.

Special machinery built to order; let us estimate on your work. Capital Foundry and Machine Company, Frankfort, Ky.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

A large English firm of machine-tool importers, having showrooms and offices in

Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

An old established firm with modern tools and equipment is desirous to communicate with an American firm to manufacture for them in Canada a line of light or medium weight machine work. Box 79, AM. MACH.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th street.

Advice; mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

Wanted—Company with good machine specialty who desire to increase output by investing small amount of capital to reorganize a plant at present in operation under a receiver; investment need not be large and a good chance for the proper parties. Box 38, AMERICAN MACHINIST.

Proposals for furnishing twelve turret gun sights will be received at the Bureau of Ordnance, Navy Department, Washington, D. C., until 12 o'clock noon, June 15, 1907, when they will be publicly opened; forms of proposals and all information may be obtained from the Chief of Bureau of Ordnance, Navy Department. N. E. Mason, Chief of Bureau of Ordnance, May 25, 1907.

Wanted—By a large selling organization, a small country machine shop and foundry within 100 miles of New York, to manufacture a new machine weighing about 500 lbs., and having a comparatively small amount of machine work, of a simple character; steady orders given, and payments made promptly in cash; exactly the opportunity that hundreds of small shops are looking for. Address Box 72, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

As superintendent or foreman of machine shop; thorough mechanic; wide experience in building machinery, tools, dies and repairs, up to date, tactful with help; A-1 references. Address Box 69, AMERICAN MACHINIST.

Position wanted; am 37 years old, have been employed in the office of one firm, who manufacture small tools and light machinery for 21 years and have a practical business knowledge acquired by such a training. Ernest L. Whiton, 23 Perry St., New London, Conn. 'Phone 643-5.

MASSACHUSETTS

Mechanical draftsman with 4 years' drawing room and 3 years' machine shop experience desires to make a change; good references. Address Box 66, AMER. MACHINIST.

Toolroom foreman, acting as assistant superintendent of shop employing 200 men, manufacturing small accurate tools, desires change. Age 28; inventive and resourceful; references. Box 47, AMERICAN MACHINIST.

Wanted—Position as machine tool and machinery salesman by a practical shop man, expert machinist and toolmaker; 32 years of age, considerable traveling experience; business getting salesmanship guaranteed; east of Buffalo; A-1 references as to ability, integrity, honesty, etc. Address "J. I. J. P.," care AMERICAN MACHINIST.

MICHIGAN

Young man; 33 years old, having "made good" in machine shop as foreman, with large automobile company, looking for better position in that line; can furnish proof of ability in every detai. Box 67, AMER. MACH.

NEW JERSEY

Mechanical draftsman wishes to change; four years' experience, technical Box 74, AMERICAN MACHINIST.

Master mechanic or foreman open for engagement; excellent tool maker and designer of labor-saving devices; strong executive and good manager of help; A-1 references. Box 977, AMERICAN MACHINIST.

Position Wanted—Superintendent, assistant, or charge drawing room; light or medium machines; fifteen years' factory experience machinist and draftsman. Address "Capable," AMERICAN MACHINIST.

Position as foreman of toolroom or intricate manufacturing; have had eight years' experience as foreman; am up to date with the latest methods in doing work quickly and accurately; can furnish best of references in regard to ability in handling men and as a mechanic. Box 60, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 77, AMERICAN MACHINIST.

Draftsman with experience in heating, power and machine equipments desires position. Box 58, AMERICAN MACHINIST.

Experienced designer; printing presses and book binders' machinery a specialty; desires situation. Address Box 76, AMER. MACH.

Draftsman, mechanical, first class, wants position; 10 years of practical experience in automatic machinery and tools. Box 44, AMERICAN MACHINIST.

General foreman at liberty, light or medium work, tools designed for rapid production; work systematically handled. Box 53, AMERICAN MACHINIST.

Superintendent solicits correspondence from parties wanting an up-to-date live man; good mechanic and executive; replies treated confidentially. Box 49, AMERICAN MACHINIST.

Superintendent, high-class, aggressive and energetic; manufacturing, machine building, and foundry lines, good record for reducing costs and raising output. Address Box 59, AMERICAN MACHINIST.

Machinist and toolmaker, foreman; age 29; expert in all mechanical branches; 16 years' experience; improves and develops machinery; highest references; wants position. Box 65, AMERICAN MACHINIST.

Chief draftsman of large concern desires change; broadly qualified in automatic machinery and up to date in factory details; exceptional inventive ability. Address "Chief Draftsman," AMERICAN MACHINIST.

Foreman machinist of wide experience, thorough all-around mechanic, desires change; any class of work; good reader of drawings; excellent references; age 32. Address Box 73, AMERICAN MACHINIST.

First-class mechanical draftsman and designer; college graduated, at present employed by a large concern desires to negotiate with first-class firm concerning engagement; shop experience. Box 62, AM. MACH.

A young mechanical engineer with proved ability as an inventor and designer, now employed as superintendent of a typewriter factory, wishes a position of responsibility offering chances for advancement. Address Box 57, AMERICAN MACHINIST.

Technical college graduate, Sweden 1899; 6 months' experience as machinist and molder; 2 years 8 months draftsman at toolmachinery company, Sweden, 3 years 6 months engineer at stove and farming machinery company, Sweden, 1 year 10 months draftsman in America; wants position as draftsman. Address Box 78, AMER. MACHINIST.

PENNSYLVANIA

Position Wanted—Electrical designer and draftsman wants change; 14 years' experience; technical graduate. Box 61, AM. MACH.

Experienced designer of larger gas, steam, plunger pump engines, German University graduate, with executive ability. Box 54, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

ILLINOIS

Detail draftsman; one who has had experience on machine tool work preferred; preference also given Swedish, Danish or Norwegian technical graduates; state whether married or single, age, experience and salary expected. Address Box 64, AMER. MACHINIST.

INDIANA

Wanted—Foreman for assembling department of factory manufacturing gasolene engines. Box 16, AMERICAN MACHINIST.

IOWA

Wanted—Foreman for gray iron foundry employing from 20 to 30 molders; must be strictly non-union and thoroughly familiar with cupola practice; permanent position for right party, with excellent chance for advancement; town of 20,000 population; first-class public and normal schools; none but temperate married men need apply. Address Litchfield Mfg. Co., Waterloo, Ia.

MASSACHUSETTS

Wanted—A designer experienced on automatic machinery; a man with technical education preferred; position permanent; in replying state experience, age, nationality, salary expected, and references. Box 63, AM. M.

MICHIGAN

We have a first-class position open for a mechanical draftsman and engineer who is familiar with duplex pump designing and shop practice. Box 991, AMER. MACHINIST.

MINNESOTA

Wanted—First-class toolmaker; must understand trade thoroughly; apply to Monitor Drill Co., Minneapolis, Minn., giving age, reference and wages.

MISSOURI

Wanted — Six first-class erecting machinists; also 3 gas engine erecting engineers; state references, experience, and salary expected. Box 35, AMERICAN MACHINIST.

Draftsman wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Tool die and instrument makers accustomed to accurate complicated work; steady work and good wages to thoroughly competent men; give references. Address Box 438, AMERICAN MACHINIST.

Wanted—First-class mechanical draftsmen by large firm near New York; draftsmen familiar with metallurgical work preferred; state experience, age and salary expected. Address "Metallurgy," AMERICAN MACHINIST.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK

Wanted—Foreman for brass Monitor-lathe room; must be experienced, energetic man; apply by letter only, stating age, experience and references. Nathan Mfg. Company, 416 East 106th Street, New York City.

Wanted—Assistant machine shop foreman familiar with latest methods of production, valves and fittings; must have good executive ability to get out work quickly; permanent position for right man. Box 56, AM. MACH.

Wanted—By an old established concern, foreman familiar entirely with making of steel castings, suitable for high pressure steam; state age, married or single, if now employed and experience in detail. Box 55, AMERICAN MACHINIST.

Engineer wanted; first class, for three or more months for summer camp in Adirondacks; one experienced in operating Otto Gas engine, also electric light and storage battery plant. Address with references and full particulars of experience, "A. L.," AM. M.

Non-union toolmakers accustomed to small accurate work; 42 cents per hour, 54 hours per week; non-union screw machine hands, accustomed to Brown & Sharpe hand and automatic machines, 35c. per hour, 54 hours per week; machinists accustomed to lathe, drill press and bench work, 30c. per hour, 54 hours per week; steady employment guaranteed to first-class men. Apply Jones Speedometer Factory, New Rochelle, New York.

Wanted—Assistant foreman over a machine room of about thirty men (engine lathes, turret lathes, drill presses, shaper, milling machines and vise work) in a manufacturing establishment in New Jersey about fifteen miles from New York; applicant must not be over forty years old, of good executive ability, a first-class mechanic, and must know how to lay out work to advantage; a good and permanent position to a bright, energetic and hustling man. Address giving references and salary expected. "C. B.," P. O. Box 2062, New York City.

OHIO

Wanted—Experienced punch and shear draftsman; state qualifications, age, ary expected. Box 70, AMER. MACHINIST.

Wanted—Several draftsmen familiar wi steam hammer designing; state age, experience, and salary expected. Box 71, AM. M.

Wanted—In middle west, first-class machinists on floor and vise machines; no labor troubles; steady employment at good wages. Box 1, AMERICAN MACHINIST.

Wanted—First-class die and toolmakers on bench and vise work on forming, embossing and cutting dies; steady employment, first-class wages; excellent conditions; no labor troubles. Box 37, AMERICAN MACHINIST.

Forge foreman for general forge plant, consisting of steam drop hammers, Bradley ham-

mers, welders, polishers, grinders and assemblers. Apply, with references, also stating experience and salary expected. Box 43, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Lathe, planer and boring mill hands. The Blaisdell Machinery Co., Bradford, Pa.

Draftsman Wanted—A technical graduate preferred not over 26, as assistant instructor of mechanical drawing; give full particulars of education, experience and salary expected. Address Box 68, AMERICAN MACHINIST.

Wanted—An energetic superintendent for a plant having pattern shop, foundry and machine shop, employing 100 men, and building machine tools and other specialties; a good opportunity to get into a growing business; must be capable of handling men, and getting out good work at reasonable cost; position permanent for a first-class man. Box 50, AMERICAN MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

WISCONSIN

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee.

Wanted—First-class general foreman, for large machine and erecting shop, building heavy machinery; liberal pay to one who can produce results; do not apply unless you can show good record. "X. Y. Z.," AM. MACH.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling futre vacancies as they occur; wants men now employed; give full experience and reasons for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

For Sale

Test Indicators. H. A. Lowe, Cleveland, O.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

Two hydraulic presses, will take in material 35"x35". Address Shartle Brothers Machine Company, Middetown, O.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, Ohio.

For Sale—Ten volume library covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

For Sale—One branch of a well established line of machine tools in the middle west with good foreign and domestic agents and five month orders ahead. Address "Special," AMERICAN MACHINIST.

For Sale—60 h.p. Bigelow return tube boiler; A-1 condition; 80 lb. pressure allowed by Hartford Steam Boiler Insurance Company; just removed to install larger one. West Haven Mfg. Co., New Haven, Conn.

Patent No. 845,994 "Safety Device for Firearms," March 5, 1907 for sale; price $300. Patent No. 848,280 "Time Control of Automatic Temperature Regulators," March 26, 1907, for sale; price on application. Address Frank Beckwith, Evanston, Wyoming.

A rare oportunity; a fully equipped machine shop for general repair or manufacturing purposes with established business; no canvassing necessary, fine location, low rental, will sell at a sacrifice to quick buyer, (with pending contracts,) on account of illness of proprietor A Krancke, AM. MACH.

For Sale—Complete electroplating outfit, including one 500 ampere dynamo, one 5 and one 10 horse-power motor 500 volt direct current; 3 cedar and 3 iron tanks, together with nickel, brass, bronze and copper anodes rheostats, switches, grinding and polishing lathes, carborundum, bull neck, canvas, felt and cotton wheels, power press, wood pulleys, shafting, hangers, belting and supplies. W. T. Coulter, 201 Outlook Bldg., Columbus, Ohio.

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Morse Twist Drill & Mach. Co., New Bedford, Mass.
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McLeod & Henry Co., Troy, N. Y.

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Dodge & Day, Philadelphia, Pa.

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Cleveland Wire Spring Co., Cleveland, Ohio.
Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

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Boston Gear Works, Norfolk Downs, Mass.
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Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
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Manufacturing Equipment & Engineering Co., Boston, Mass.

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Niles-Bement-Pond Co., New York.
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Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
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Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
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Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Bros. Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., Ntw York.
Keuffel & Esser Co., New York.
Soltmann, E. G., New York.

Blue Print Paper

Keuffel & Esser Co., New York.
Soltmann, E. G., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Boiler Setting

McLeod & Henry Co., Troy, N. Y.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, Ohio.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Philadelphia, Pa.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del
Binsse Mach. Co., Newark, N. J
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.

Boring and Turning Mills Vertical—*Continued.*
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote
Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction
Electric Controller & Supply Co., Cleveland, O.

Brazing
Industrial Oxygen Co., New York.
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Brazing and Tempering Powders
Phillips, Lafitte Co., Phila., Pa.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson Mass.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels

Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing
Industrial Oxygen Co., New York.
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Manufacturers Foundry Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.

Castings, Steel—*Continued.*
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co. Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co. Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor, Locks, Conn.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Bartlett, E. E., Boston, Mass.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Woods Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic
Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic
Sturtevant Co., B. F., Hyde Park, Mass.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Slushing
Warren Bros. Co., Boston, Mass.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Machine Co., Boston, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Corundum
See Grinding Wheels

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery
Veeder Mfg. Co., Hartford, Ct.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.

Cranes—*Continued.*
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Phila., Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.

Cutting-off Machines—*Cont.*
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Cyclometers
Veeder Mfg. Co., Hartford, Ct.

Diamond Tools
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York City.
Safety Emery Wheel Co., Springfield, Ohio.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.

Drilling Machines, Upright—*Continued.*
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.

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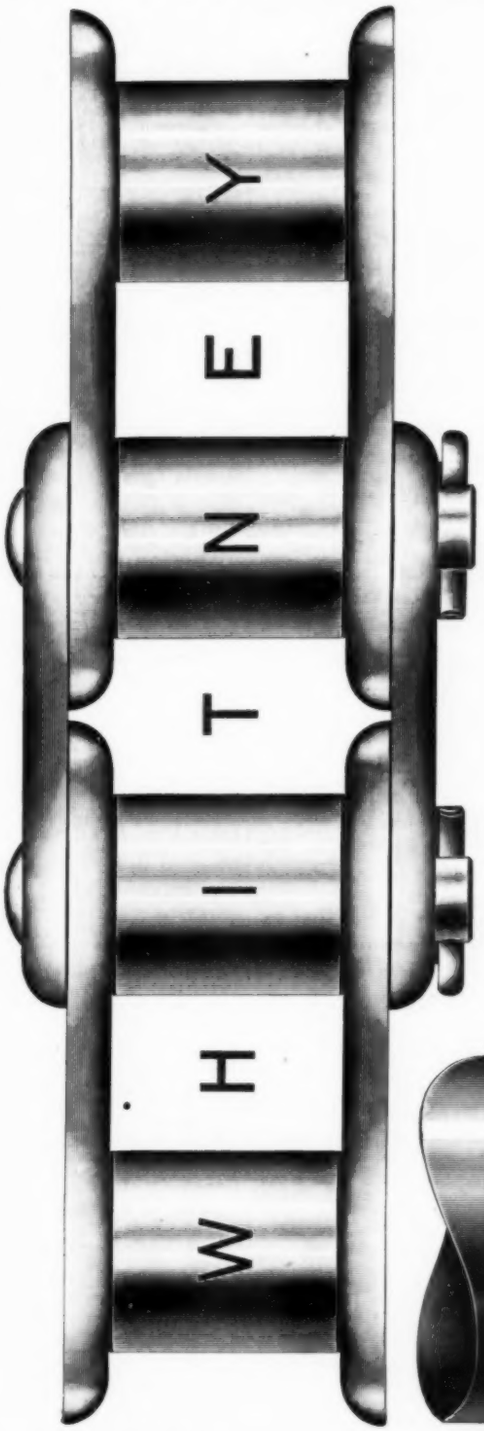
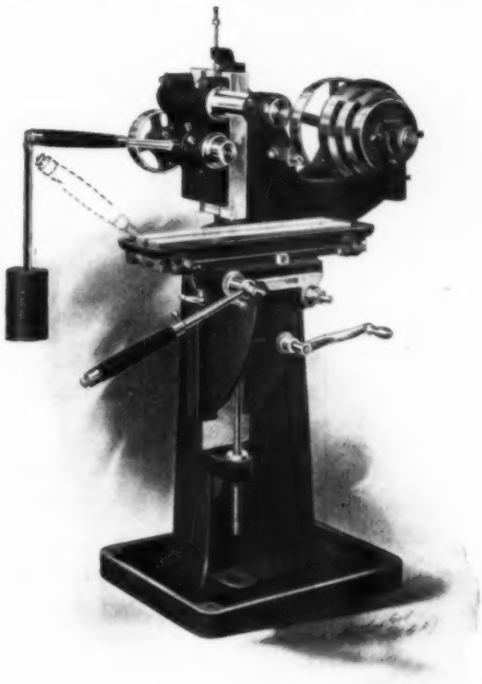
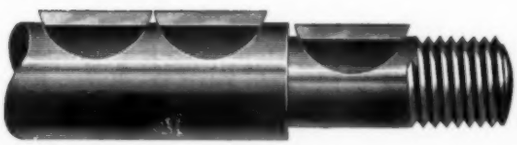
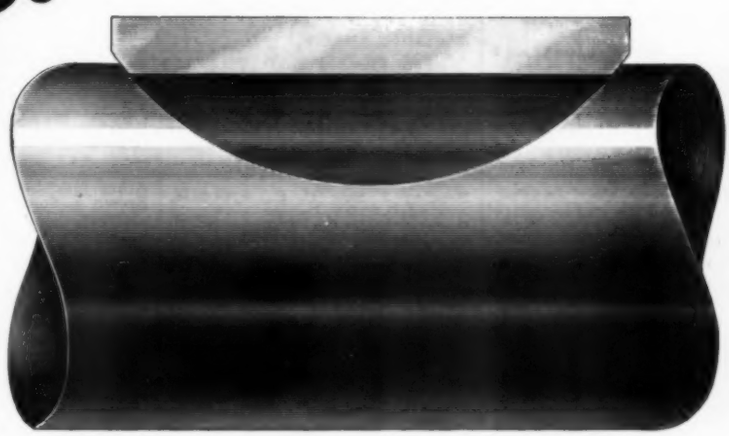
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Dynamos—*Continued.*

Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. Co., Chicago, Il.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Mechanical and Electrical

Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Eng. Co., Stamford, Conn.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Oil

Remington Oil Eng. Co., Stamford, Conn.

Engines, Steam

Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers

Bormay Engraving Co., New York.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Machinery Exchange, Boston, Mass.
Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric

Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Heller Bros., Newark, N. J.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Fire Brick

McLeod & Henry Co., Troy, N. Y.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery

The Scranton & Co., New Haven, Conn.

Forgings, Drop

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.

Forgings, Drop—*Continued.*

Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic

Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine

Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel

Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Crescent Forgings Co, Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers

Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester, City, N. Y.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co, J., East Boston, Mass.

Gages, Steam

Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gas Blowers and Exhausters

Sturtevant Co., B. F., Hyde Park, Mass.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut

Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Chicago, Ill.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co, Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.

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Gears, Rawhide—*Continued.*
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets
Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas
American Gas Furnace Co., New York.

Gibs
Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite
Dixon Crucible Co., Jos., Jersey C..y, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, Ohio.

Grinders, Center
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Machine Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk
Bath Grinder Co., Fitchburg, Mass.

Grinders, Disk—*Continued.*
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Gardner Machine Co., Beloit, Wis.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Independent Pneumatic Tool Co., Chicago, Ill.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw
Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co, Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding and Polishing Machinery
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinding and Polishing Machinery—*Continued.*
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Machry. Co., Cleveland, O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Gardner Mach. Co., Beloit, Mich.
Goodell-Pratt Co., Greenfield, Mass.
Graham Mfg. Co., Prov., R. I.
Greenfield Mach. Co., Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Wells Sons Co., F. E., Greenfield, Mass.

Grinding Wheels
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames
Athol Machine Co., Athol, Mass.
Cleveland Stone Co., The, Cleveland, O.
Niles-Bement-Pond Co., New York.
Pike Mfg. Co., Pike, N. H.

Gun Barrel Machinery
Pratt & Whitney Co, Hartford, Conn.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., The, New Haven, Conn.

Hammers, Steam
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting
Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Hoisting and Conveying Machinery
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
United Engineering & Fdry. Co., Pittsburg, Pa.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker-Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hobbs, Clinton E., Boston, Mass.
Moore Co., Franklin, Winsted, Ct.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Chicago Flexible Shaft Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

A Large Engineering Works in Holland

Illustrations and Details of the New Plant of the A. F. Smulders Shipbuilding and Engineering Works at Schiedam

BY J. B. VAN BRUSSELL

These works, recently erected, occupy an area of over 15 acres on the left bank of the river Maas, at Schiedam, near Rotterdam. The main buildings are each divided into three bays. The construction is of steel and the general design may be gathered from the illustrations. The main columns are carried up to a hight of 36 feet in the center bays and 22 feet for the side bays. On the tops of the columns

FIG. 1. THE LATHE SHOP, WITH ITS LOW LINE SHAFT, AND HIGH WINDOWS AND BRICK FLOORS

are the runways for the electric traveling cranes. The girders of the latter are of light lattice-work construction, the columns supporting the roof. The hight of the main bay, not including the skylight, is 61 feet 6 inches from floor level, and the hight of the side bays 39 feet. The main bays are 78 feet 9 inches wide and the side bays 45 feet 9 inches; they all run the full length of the buildings, 460 feet. The shops are well lighted by two continuous-roof skylights and side and end windows high up in the walls.

Fire Protection for Patterns

The north end of the east building is devoted to the patternmaking and woodworking departments on the ground level; above this is the pattern storage. Although this department comes under the main roof, it is separated from the rest of the building by a concrete wall, in order to guard against fire. This is more necessary as the next department is the foundry, which occupies the whole width of the building for a length of 99 feet. This has two cupolas, with an electric lift. For heavy castings there are two pits, each 16 feet in diameter by 15 feet deep. They are lined entirely with a riveted-plate structure, perfectly water-tight. There are two core stoves, 21x21 feet, and a portable stove for drying molds by turning the productions of combustion of a coke fire through them. In this foundry castings up to 25 tons are made. The brass foundry is in the side bay.

Low Shafting and Blank Walls

In this section are the coppersmiths' shop, the painters' shop and the fetling or casting-cleaning shop; these are again divided from the main building by another concrete wall, in which is a doorway which gives admission to the machine shop of the main engineering department. The northern end of the east bay is occupied by lathes. The central bay is used for erecting, while the west bay is used as a finishing shop. The drive is electrical; the main line of shafting is run on bearings supported on box-section beams carried by the columns, with countershafts beneath. On the east side there are three lines of shafting, each with its own motor. In Fig. 1 note the line of shafting, about 3 feet from the ground, next to the wall, with countershafts above; observe that the only light comes from upper windows, and that there are no windows below the countershafts; notice, too, the brick floor.

Plate-working Machines

The west building is devoted to plate work for structures and shipbuilding This department is more flattering to English and American pride than the engineering section, as most of the machines used here are of British and American origin. The line shafting is overhead in this case, electrically driven for tools not having their own motors. Again note the absence of low windows (Fig. 2). One of the most interesting machines is a

Craig & Donald's punching and shearing press, with an angle-iron cutter, shown in Fig. 3. Then there are several big-plate edge planers, a number of automatic saws, drills, plate-bending machines, angle-iron benders, and other machines of the usual type for construction work. Another interesting and useful tool is a John's splitting shear, by means of which plates of any length and width can be sheared in two on any line.

The forge is in the west bay and contains a hydraulic press of 250 tons. There is a steam hammer by Glen & Ross, and also two Massey steam hammers. There is a plate-bending press, which can be used for flanging floor plates and other work. At the end are two furnaces for heating forgings. The smiths' fires are in two rows on opposite sides. The hearths are fitted with a complete exhaust system for carrying off smoke.

FIG. 2. SHIPBUILDERS' ERECTING SHOP, ALSO USED FOR STRUCTURAL WORK

Hand and Air Riveting

There is a pneumatic system installed for calking and drilling, and some riveting is also done by air pressure, though most is by hand. The air-compressing plant is on the Ingersoll-Sergeant system.

There is also an electric locomotive crane which takes current on the overhead-trolley system and runs on the rails laid down in the yard. In this way the crane can be run on to the landing stage in the erecting basin, down to the building slips, along the quay, or into the two principal buildings. The rails are of standard gage, and when connection is made, as it will be shortly, between the works and the railway, the yard will be in communication with the whole railway system of the country. The works are now employing about 2000 men.

Echoes from the Oil Country—Blower and Gas-engine Troubles

By W. Osborne

Positive blowers are not very complicated pieces of machinery. The man who was selling them thoroughly understood them and he thought that everybody else should, also. He knew that they were good, well-built machines, at least those that he sold were, and he was not saying anything about the other fellow's. He was rather surprised to receive a letter from his house directing him to go at once and see a machine that had been lately sent out. "They say"—so the letter read—"that it does not deliver half as much wind as we claim for it. If their cupola is not larger than they think it is they must be handling it wrong in some way. Find out the trouble. No matter what it is, it is likely to be blamed on our blower until you show them differently. They say the delivery pipe is large and not long, and that it is being run up to speed, etc."

The Salesman Arrives

He was received very courteously at the office of the works, but they were in trouble. "We cannot make any fine tests of it, but are not able to melt the iron. You claim fourteen tons an hour and we are not getting much over half of it. Certainly you can see it, and all the surroundings. The boss molder can tell you all about how it acts."

The boss molder was not in a very good humor about it apparently. "Must be an awful job inside. Don't get any kind of a grip on the wind. You just stay right here till we start up."

That was his intention, and in the meantime the salesman looked things over. Everything appeared to be in good shape. The plant was a new one and well built. The blower was in a room by itself where it could be kept clean. On starting up, it was seen that it was running the proper speed and was not making any more noise than was usual. The salesman examined everything carefully. Not a screw was loose, and not a bearing getting warm, nothing anywhere to indicate trouble. Although he was not of a suspicious nature, he began to wonder if some opposition company had a friend in the foundry foreman. He started out to see how things were moving around the cupola, when he was met by the foreman, who looked pleased.

The Situation Changes

"You're the stuff," said he, "she is doing better than she ever did." As he had not done anything, matters were not made any clearer to his mind; but he stood around for some time and tried to figure the situation out.

Everything seemed to be in good shape around the cupola, and the tender said that he was handling it in the same way that he had before. "But she's got different wind today from what ever she had before. Her's humping herself like her ought to now." That expressed his ideas.

The salesman thought it best to take one more good look around the blower. Everything was all right, and again he started for the cupola, and again he was met by the foreman. "What in the dickens did you change that blower for? After you fixed it, why didn't you let it alone till I got this heat off?"

"I didn't fix it. I haven't done a thing to it since I came, but look at it," declared the salesman.

"I know better than that."

"It's a fact, whether you believe it or not. I haven't changed a thing. I looked it over, but did not see a thing that I could do to help it."

"You helped it all right, and if your looking at it did it I want you to see if it won't help it some more."

A Mystery Solved

They went into the blower room and looked at the blower a minute. "Now you stand right here and I will see how she is melting." In a few minutes he came back and reported that everything was going well. In the meantime a light had dawned on the salesman and be quietly closed the door and waited. It was not long before the foreman was back. "Confound your hide. Why can't you let things alone?"

"Keep cool. You are not going to have any more trouble. See if everything is not all right. I will go with you."

That blower did not give any more trouble for the rest of the heat. After the bottom was dropped, the salesman explained the mystery.

"That blower is made to move air. As it takes about 30,000 cubic feet of it to melt a ton of iron, it has to move a lot of it to melt 14 tons an hour. You have put it into a very nice, tight room, and all the chance that it has to get that air is to suck it in at the cracks where the belt comes through, and they are not big enough. The way I fixed it was to leave the door open part of the time. Either cut a hole in the wall or throw the door away."

The foreman smiled a sheepish grin. "Well, I'll be——."

Gas Engines and Air

A gas engine does not have to get as much air in proportion to its size as a blower does to be a success, but it is just as set in its way about not working cheerfully unless it does get as much as it needs, and more than one gas engine has been given a bad name just because it was put where it did not get air as it should. It is not enough to see that there are openings enough to let air in, but it should also be seen that the fluid that comes in through the openings is really air. A mixture of dust, water vapor, carbon dioxide, smoke and rust may be supplied plentifully enough to fill the air space without being in exactly the right combination to take the place of fresh air.

An expert gas-engine man spent several days trying to locate the trouble a firm was having with an engine. It was in a basement, or perhaps in what the term sub-basement would better describe, and some days it would run very well indeed while on other days it could not be made to do so.

After he had convinced himself of the cause of the trouble he had the job of convincing the firm of it, and then he had some more trouble in getting them to put in a pipe large enough to bring a suitable amount of air from a safe place. It is rather hard to prove that an engine that has a two-inch air opening at the engine needs an eight-inch box to bring the air from across under the room and around several corners and up two stories, and that it should end in a box that can have a screen with a surface of several square feet. The more the better.

On the air question every gas engine should be treated as though it were a tubercular patient at a sanatorium.

FIG. 3. A LINE OF MOTOR-DRIVEN PUNCHING AND SHEARING MACHINERY

Lantern Slides for Shop Instruction

A Method Devised to Teach Japanese Workmen, Which Should Be Equally Good in Any Trade School or Shop

BY CHARLES A. FRANCIS

In the course of conversation between the director of the Tokyo Koto Kogyo Gakko and myself some time ago, relating to the training of Japanese workmen, the question of making use of lantern slides was taken up. Being so impressed with the idea that good work could be done in this way, I proposed to prepare a set of slides, the object of which was to show some of the mistakes workmen are in the habit of making, but in such a way that the younger readers of the AMERICAN MACHINIST to see some of the slides as made for this work, I have had prepared especially for their benefit the photographs here shown, which, I believe, need very little, if any, explanation.

Figs. 1 to 4 illustrate those sayings by Van Dervoort in his book, "Modern Machine Tools": "The lathe bed must not be used for an anvil, nor yet as a resting place for tools, wrenches, chucks, etc. Have a shelf or tool rack for this purpose." "A good machinist never ill treats his lathe, and always keeps it clean, tidy and well adjusted."

Fig. 5 shows a widely used tool and one a first-class workman does not like to lend. Why? Ask one, and I think he will tell you that you do not know how to grind it, or if you do, you seldom do it.

Fig. 6 shows three well-known tools, the "center-punch;" though they are very simple tools to grind, they are very seldom found in what could be called first-class shape. In this figure is also shown a section of a piece of metal upon which each of these punches has been used.

Fig. 7 shows what the effect is on center bearings when they are run between lathe centers without being properly lubricated.

Fig. 8. It is not likely that many of the young readers of this paper can read Japanese, therefore the following translation is given: "A mandrel should never be marred with the screw of a dog; use the dog in the proper place."

Fig. 9 shows how the knock-out rod, as furnished with the Brown & Sharpe Manufacturing Company milling machines, can be used to good advantage in removing the line center from its bearing in the lathe. There are nine lathes of American make in this room, and each is provided with one of these rods, also a hook *A* on which it may be kept when not in use.

Each rod has a piece of copper let into

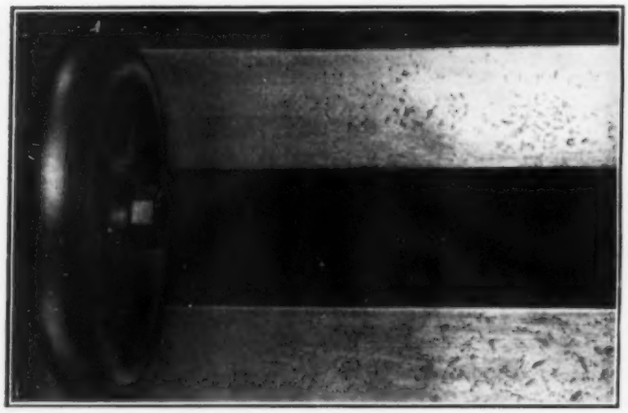


FIG. 1. DON'T USE THE LATHE AS AN ANVIL

FIG. 2. NOR AS A RESTING PLACE FOR TOOLS

FIG. 3. A TOOL CABINET FOR LATHE

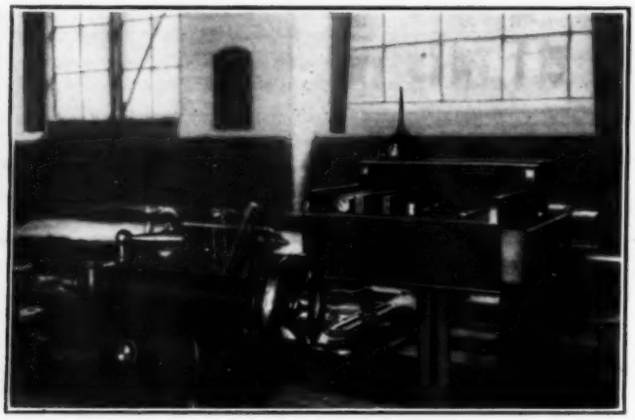


FIG. 4 ANOTHER STYLE, BEHIND LATHE

they would be more strongly impressed on the mind than could be done by simply telling them.

While the idea was to make this set of slides for the benefit of workmen, it was also hoped that certain ones would suggest to the manufacturers, should there be any present, how they could not only encourage their workmen to do better work but at the same time make more profit by providing a few inexpensive accessories to the machines in their factories.

Believing that it may be of interest to

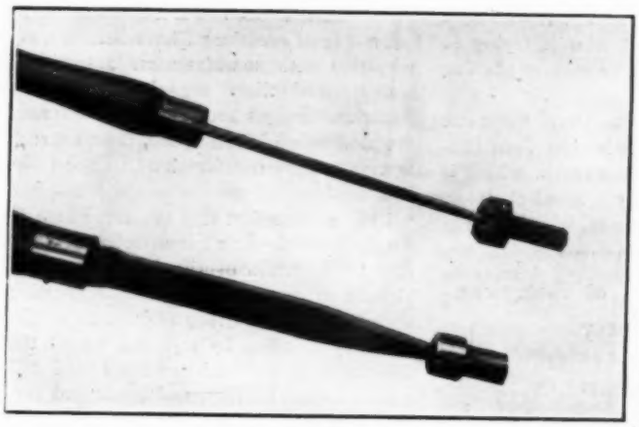


FIG. 5. GOOD AND POOR SCREWDRIVERS

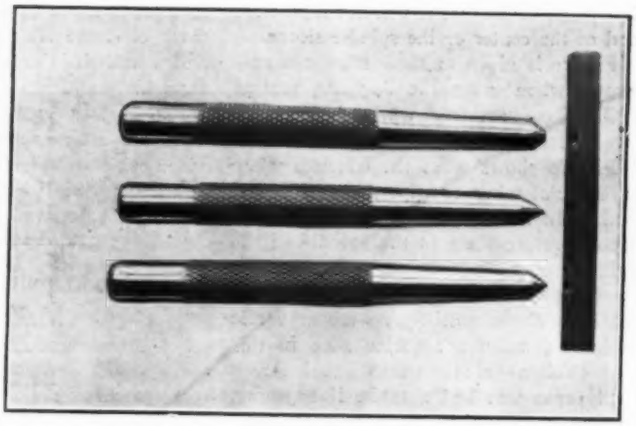


FIG. 6. DULL AND SHARP CENTER PUNCHES

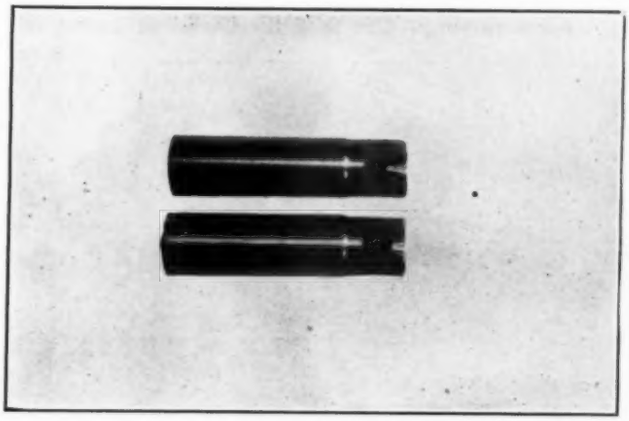


FIG. 7. SHOWING WEAR OF CENTERS

FIG. 8. WORK MARRED BY DOGS

FIG. 9. DRIVING OUT CENTERS WITH A ROD

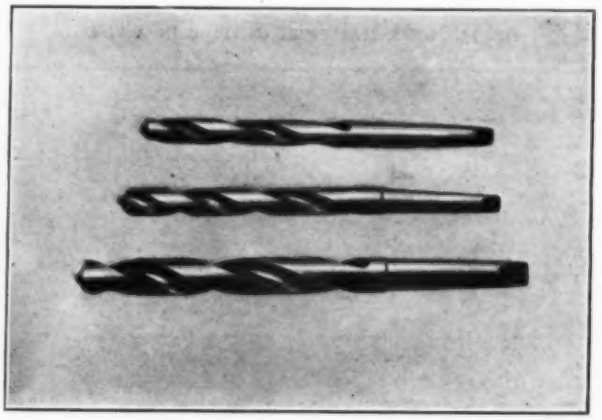


FIG. 10. DRILLS BENT BY LATHE DOGS

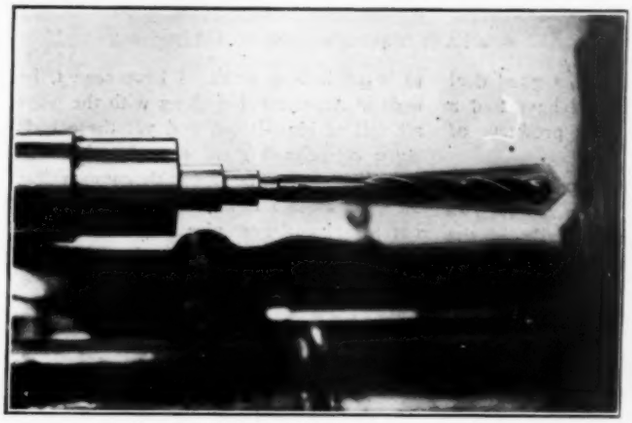


FIG. 11. DIRT MAKES DRILL RUN "OUT"

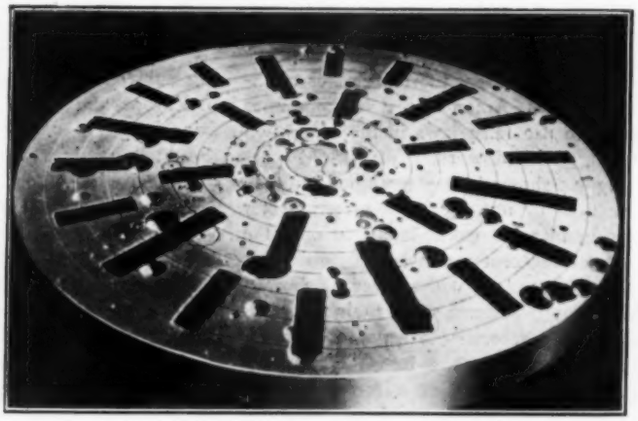


FIG. 12. ABUSE OF DRILL-PRESS TABLE

its end in order that it will not injure the end of the center or the spindle sleeve.

Fig. 10 is given to show what one may expect when using the dog for holding drills from rotating while drilling between lathe centers.

Fig. 11 shows what the effect is when care is not taken to wipe the surfaces of both drill and socket free from dirt before inserting them in the spindle of the drill press. The shadow shows how it runs out of true.

Fig. 12 shows a drill-press table. While looking through a machine shop in this city (Tokyo) a few weeks ago I saw a drill press that had a table, if anything, in poorer shape than the one here shown, and was told that the table now in the press was the third one that had been made for the same machine.

foot-prints made by a workman who is at work on lathe *X*, and who is trying to find a wrench in order to remove the dog from his work.

Fig. 16 is supposed to show the same workman after each lathe has been provided with an alligator wrench, which is attached to the lathe by a small chain, so that it will not walk away.

The Condemning of American Machinery

By Conrad

With regard to the short article on "American Machinery Condemned," page 713, I should like to say a few words on this subject. I have traveled a good deal in Europe and America, and have had a fair chance to compare the products of these two continents.

In England, generally, things are done thoroughly. Special attention is given to each and every detail, especially in the building of machine tools. The fitting and scraping are of a much better kind than is usually seen in this country, and I also think the general appearance of most of their machines is a little ahead of American ones. I don't say they do better work, probably they don't do as good.

Design Good—Finish Poor

On several occasions I have been in conversation with manufacturers over there, and most of them say that while the American designs are first class as far as the mechanism is concerned, the construction and finish fall far short of the English standard.

I know for a fact that one large firm in England which deals extensively in American tools always overhauls the machines shipped from this country before putting them into use, and they make sure of the accuracy of them by re-lining up all the important parts, such as head and tail stock in engine lathes, and heads and turrets in turret lathes.

Patched-up Work

One thing the English strongly object to is patched-up work. I have seen lathe beds in American foundries with the ways all full of blow-holes, and yet these beds were considered good enough when the holes had been filled in with composition. In some cases I have seen pieces of a bed cut away, and new pieces inserted, so as to enable the bed to be used. This may be all right for American machine shops, but it is not good enough for England.

Trying Out New Tools

Whenever they put new machinery on the market over there it is not unusual

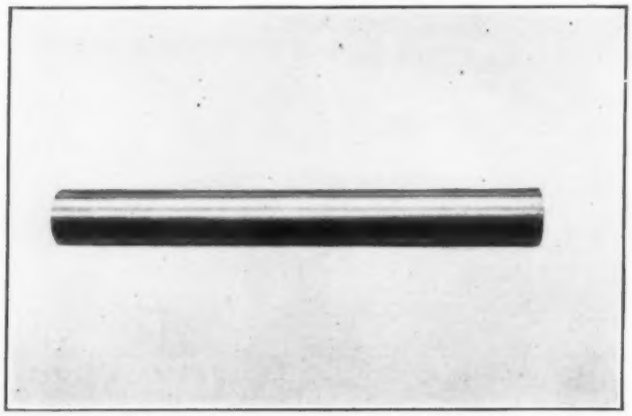


FIG. 13. WORK MARRED BY GRIPPING IN A VISE

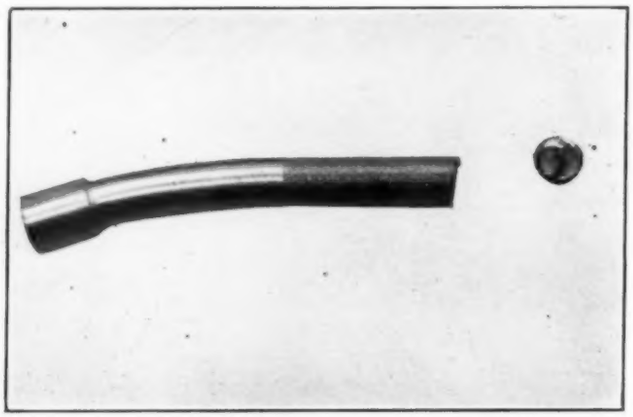


FIG. 14. WORK NOT PROPERLY CENTERED

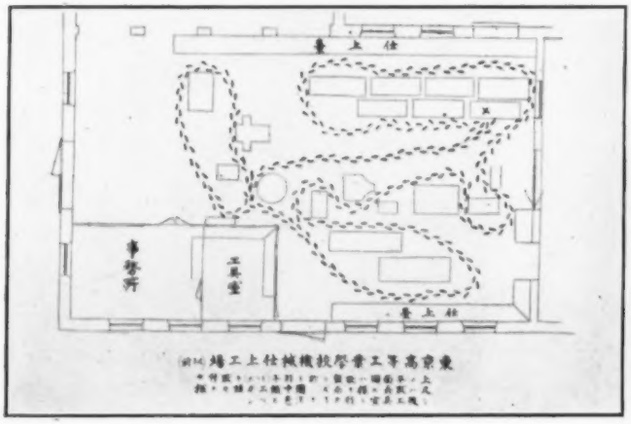


FIG. 15. STEPS TAKEN TO FIND WRENCH

FIG. 16. WRENCH CHAINED TO LATHE

Fig. 13 shows that there are other workmen besides Americans that sometimes forget to use false jaws in the vise when holding finished work.

Fig. 14 shows how a workman tried to save time by not putting a proper center bearing into his work, but used only the mark of the center punch.

Figs. 15 and 16 will answer to show, I think, how workmen spent their time, that should be otherwise spent, looking for tools. They also show how the manufacturer can, by providing a few tools, help this. Fig. 15 is supposed to show the

for a machine to run for a year on trial in their shops before they are satisfied that it is the best and the most efficient they can produce. Very few firms over here do that, though I believe Brown & Sharpe, and one or two other large firms, always do. I have also heard them complain of the poor quality of cast-iron used in beds, and of the short time the surfaces take to wear out of alinement.

GERMANS MORE LIKE US

French manufacturers are almost like the English in respect to finish and appearance, but the Germans are more of the American style. I remember once, when overhauling a large German boring, milling and drilling machine, I found a cast-iron worm and worm wheel in the feed box. Needless to say, the teeth on the cast-iron worm were worn almost away.

REQUIREMENTS SHOULD BE CONSIDERED

I think that, considering the enormous export trade of this country, more attention should be paid to the requirements of the country to which the machines are being shipped. I know that, as the trade has been so very busy lately, many points have been skipped which would not have been passed had the manufacturers had more time to spare. Still I think we should not be the losers if a little more attention were paid to the points mentioned. I do not wish to cause any offense by these few statements, as I only repeat what I have seen and heard.

Alloying Copper and Iron

The alloying of copper and iron has never been productive of good results to those who have tried it. If copper and iron are melted together and poured into castings, the alloy is not homogeneous, but shows nodules of iron that separate out. It is the separation of these nodules of iron that has prevented the use of these alloys.

It has now been demonstrated that the reason copper and iron will not alloy is on account of the carbon that the iron absorbs in melting. If the iron and copper be melted together in a clay crucible so that no carbon can be taken up, the resulting alloy is perfectly homogeneous and free from any separated nodules. It is the carbon absorption that is the difficulty when iron and copper are melted in a graphite crucible.

The alloys of copper and iron are red when the amount of iron is only a few per cent. When more is present, they become pink and finally a gray color, like that of iron, is produced. The copper is hardened as the proportion of iron is increased.

It is quite probable that the future will see the alloys of iron and copper used to some extent, although at the present time no use for them is known. To make them, wrought iron and copper are melted together in a crucible which contains no carbon.—*The Brass World.*

Some Apprenticeship Experiences in England

BY JAMES VOSE

The description by Osborne of the different types of mechanics in "Sammy's" shop reminds me of a shop in which I served part of my time. It was the repair shop attached to a cotton mill in Bolton, Lancashire, and some of the methods and men employed were certainly somewhat peculiar and liable to be considered quite indefensible viewed from the standpoint of the managers of concerns working on repetitive lines. The foreman was a man of considerable force of character who delighted in overcoming difficulties and making the shop as self-contained as possible, no repair job being sent out for execution unless absolutely necessary.

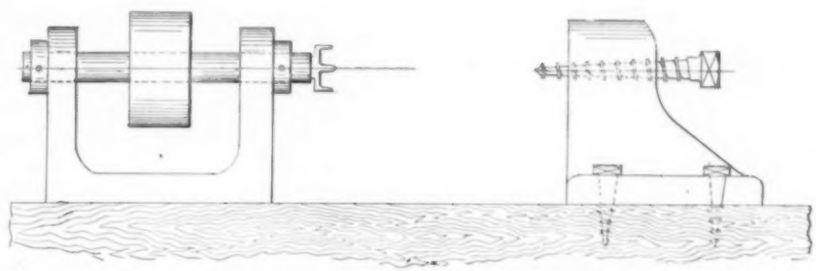
He was, however, of a very reserved disposition and preferred working harder than any of his men and keeping all the work possible in his own hands rather than "give anything away" in the shape of information. His example being followed in their own sphere by the two or three journeymen employed, the apprentices took their chance of picking their trade up. Though not encouraged to attempt too much themselves, they could scarcely help picking up a few wrinkles as they went along. There was little attempt at formal system as regards repairs; the "overlookers" or "tacklers" brought in their breakages, threw them on the floor and relied on their being taken up and dealt with by a kind of automatic subdivision of skill.

USING THE HOOK TOOL

The only direct instruction in lathe work I received was from the blacksmith, who gave me a lesson or two on the use of the T-handled "hook tool" and other hand turning tools, a few smart knocks under the chin from the tool handles being received in the process. Still, when all is said and done, there is some satisfaction obtainable from the ability to turn out a good quick job by such means, and such sentences as "replacing the uncertain operations of hand by the unerring accuracy of machinery" would appear less often were the writers better acquainted with what can be done by means of a little "know-how" and a few elemental hand tools.

The original equipment of the shop had consisted of a slide lathe—not screw cutting—of about 24-inch swing with a long bed. By dint of sundry diplomatic moves, patterns were hired and castings for a 12-inch swing back-geared hand lathe, with a compound slide rest, were obtained, and the lathe constructed in the shop, with the exception of the planing. The heads and slide rest were placed on part of the long lathe bed whence they were removed when extra-long jobs were being dealt with.

The slide rest had no setting arrangement for securing either parallelism or any definite degree of taper, and during the progress of nearly every job correct alinement had to be secured by adjustment of the base plate by careful taps with the hammer. No drilling machine was provided at that time, all drilling being done in the lathe; but later on the shop secured one by similar methods as employed in the case of the lathe.



A MAKE-SHIFT PATTERNMAKERS' LATHE

As no screw-cutting facilities existed, the foreman rigged up the compound slide rest of the hand lathe.

REVERSING WITH MITER GEARS

A reversing motion for the countershaft was, of course, necessary, and room on the line shaft being at a premium, a bracket on the plank carrying the countershaft accommodated a miter wheel revolving on a vertical stud. Two loose pulleys were used, one being attached to another miter wheel which drove the one on the vertical stud and thereby another keyed on the countershaft. The gears were always running when the lathe was in use, but as they happened to give out a fairly musical sound no objection was raised.

Screws up to 3 feet long were often cut on this lathe, though the slide-rest traverse was only about 10 inches, the position of the rest being changed on the thread being completed to the extent allowed by the rest. A speed or hand lathe for metal turning was afterward similarly added to the equipment, the screw and nut for the loose poppet being cut in the lathe last described. This lathe was on the same bed of wood with iron strips on top, as an old wood-turning speed lathe which the carpenter—who also made

all the patterns—used for miscellaneous work. As he had to come some little distance from his own shop to do the work, this man, who was a real "character," rigged up a lathe on his own bench, as shown in the sketch.

By some means he had become possessed of a bracket or stand carrying a spindle and pulley, and two collars to take care of end play. He fixed this up for the fast headstock. For the loose head he hewed out a piece of hard wood and for the stationary lathe center used the point—smoothed up a little—of a lag screw, generally known in England as a "coach screw," the lag screw being a tight fit in the head. On this "lathe" he turned hundreds of good jobs.

A High-speed Drill

He later rigged up a high-speed drill with balanced spindle for drilling wood, using a wooden grooved pulley on the vertical spindle, which was driven from a corresponding wood pulley on a light vertical shaft provided with fast and loose pulleys, which in turn was driven by a quarter-twist belt from the main shaft. In the drill spindle he used hardwood chucks for his bits, and for small drills he would flatten drill wire at the point, grind them to drill shape and drive them into individual hardwood chucks, which were retained for that size drill only.

On many of the looms in the mill "comber boards," which were wooden rails perhaps 7 feet long by 4 inches wide, and ¾ inch thick, were used. These were drilled full of small holes for the harness threads to pass through, these threads being lifted up by the Jacquard machine as required by the pattern being woven. To expedite the making of these boards, he constructed a wooden table running in V-ways like that of a planing machine, balanced it by cord, pulley and weight, and on the edge of the table fastened strips of hoop iron on which he had cut ratchet teeth according to the pitch required. By means of a spring catch he indexed the holes and got through the job quite rapidly.

This man had been familiar with cotton-machinery requirements from the time of hand looms, and could make patterns of the cams used for raising and lowering the "healds," through which the warp threads forming the backing of the cloth passed, more satisfactory than the machine makers who produced the looms, as the machine designers, naturally, were not so familiar with the working conditions as he. No supervision was exercised over this man, who was quite elderly, and who was retained under conditions which would appear almost incredible. He was fond of a week or two of a drinking bout occasionally, which the employers he previously worked for objected to.

Firms Swapping Men

At the time the objections were raised the firm he was working for when I knew him had a man not so skilled as he, but more reliable as a timekeeper, though there was hardly enough work to keep him fully engaged. By some means the two firms heard of these conditions and effected an amicable exchange of men which worked out quite satisfactorily. Work was allowed to accumulate during the old man's absence, and on his return he used to clear it off in good style. That these crude-looking methods did not preclude good business is shown by the fact that the goods produced by both firms circulate freely in the States in spite of duties.

In the mechanics' shop, a man built on somewhat similar lines, but kept more strictly in check, had considerable resource. A few good turned wood rollers about 5 feet long by 6 inches diameter, were required with turned iron gudgeons at the ends. The slide lathe was too clumsy for such work, so he turned them by hand, roughing out with gouges, as usual, employing two T-rests with a long connecting strip between them which supported the tool. For smooth finishing the rollers to fairly uniform diameter, in place of the rest used for roughing out, he had a cast-iron rail planed on the top and front edge, each end being supported by stalks screwed into the rail and fitting in the T-rests.

The rail was scraped up a little and he then employed a slide (on which by a stud and small clamp a finishing tool was mounted), resting on top of the rail, and with an outer rib which abutted against the outer edge of the rail. In the rib was fitted a handle, and with one hand grasping the handle and the other steadying the slide, very good work was done. The rail was set by trial in the case of the first roller until parallelism was obtained. If the cut was too large when the rib on the slide was in full contact with the guiding edge of the rail, he simply skewed the slide round a little and took a preliminary cut or two.

Making a Planer

After a while the foreman obtained permission to obtain the essentials of a small planer from outside. This was after the style of modern armor-plate planers, i.e., the standards carrying the cross rail moved along a box-shaped bed, the work being stationary. This was used as a portable planer at first, often being carried into the mill, fixed on a shaft and a keyway planed in position. A cabinet-shaped stand was afterward made in the shop where the machine—worked by hand—was used for a variety of jobs including the keywaying of shaft couplings. Later on it was adapted to belt driving also. A single belt was adopted for driving through trains of gears which gave different speeds to the forward and return strokes. The method of moving the belt was at any rate uncommon.

The belt fork was worked by a bell-cranked lever to one end of which were secured light sprocket chains. The chains—on opposite sides of the lever—were placed over sprocket wheels, which were prevented from revolving, and when the stroke of the planer had taken up the slack in the chain, the lever came into action, and shifted the belt. The length of stroke was varied by lifting up the chains and dropping them into gear where desired. Though open to objections, this plan sufficed.

Looking After Castings

My own duties for some time included acting as "draftsman" in the way of fetching castings in a hand cart from foundries a mile or more away; but I never had occasion to regret this, as waits, due to castings being fettled or scraped, were of frequent occurrence, and the jobs progressing in other shops could thus be observed as well as a good idea of foundry methods and customs obtained. More or less unconventional business methods obtained, a written order for castings seldom being given or required. I, personally, without specific instructions, took charge of the general run of castings, ordering and fetching them as the stock ran down.

Notwithstanding these apparent laxities I never knew of a serious mistake, and looking back in the light of a more extended experience I have considerable doubt as to whether any more orthodox system would have given better results at a smaller cost, as the most heavily-priced man concerned drew only about $9 for a normal week of 56 hours, overtime, of course, being paid for at a higher rate.

High Temperatures

The fact that high temperatures are now daily obtained by means of the electric furnace, the oxy-acetylene blowpipe and other artificial means causes an interest to be manifested in the actual temperature that is reached in melting refractory materials in the sun, whose temperature is the highest known.

Experiments with the optical pyrometer recently made are of interest as indicating the temperatures that are reached in certain operations and in the sun. These results are as follows:

Porcelain furnace	2498° F.
Glass furnace	2552° F.
Open-hearth steel	2795° F.
Melted platinum	3236° F.
Incandescent lamp	3272° F.
Arc lamp	7410° F.
The sun	13,712° F.

The results are of interest as they indicate the temperatures of familiar things.

The total production of coal in Great Britain in 1906 amounted to 265,204,716 tons, against 249,782,594 tons in 1905. The number of mine employees increased from 858,373 to 882,345.

The Arms of Gear-wheels

By E. H. Wood*

These paragraphs are the result of an endeavor to establish some simple method of expressing the relation between the proportions of the arms and the size and number of teeth of spur-gear wheels.

The following are initial assumptions:

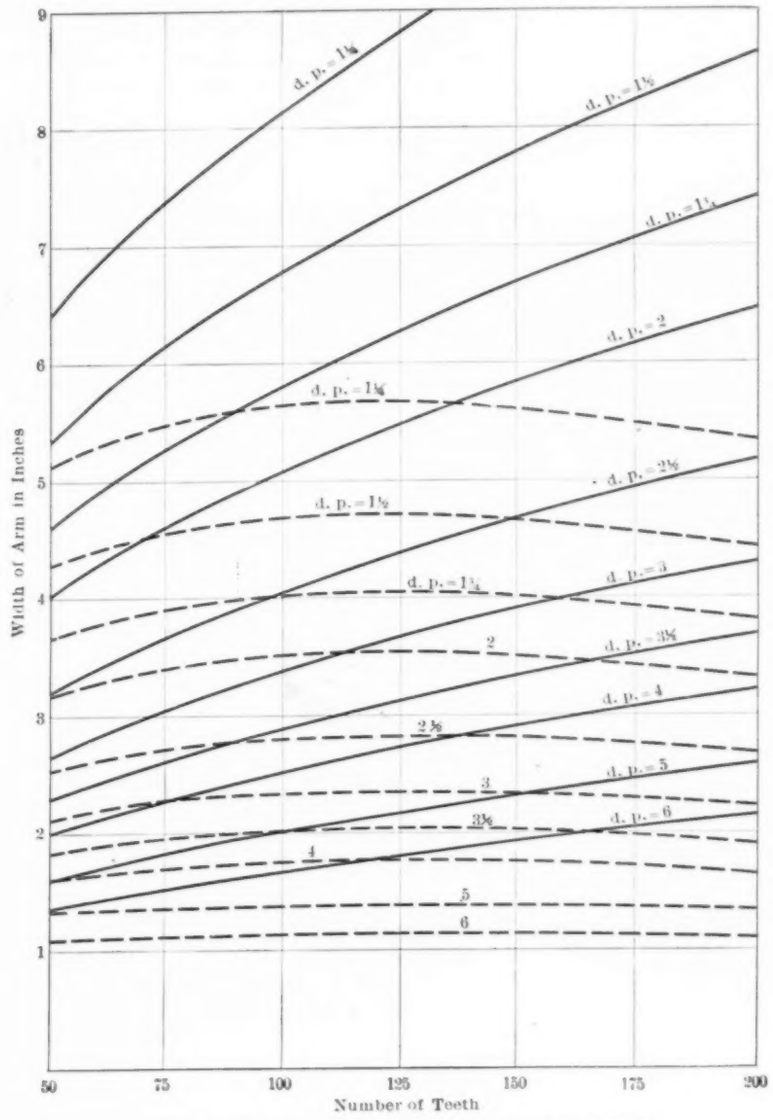


DIAGRAM OF ARM-WIDTHS FOR SIX-ARM GEAR WHEELS

I. The total load is determined by the maximum safe working load on the teeth of the gear under consideration.

II. The total load is equally distributed among the arms.

III. The arms act as cantilevers loaded at the end.

IV. The arms are of elliptical cross-section, the thickness being equal to 4/10 the width.

V. The gears have 15 degrees involute cut teeth.

*From the *Sibley Journal of Engineering.*

Regarding the accuracy of these assumptions the following may be stated:

I. The safe working load on the teeth of a pair of mating gears is determined by the tooth strength of the gear having the weaker teeth. In case of gears of the same material the teeth of the smaller gear will be the weaker. For this reason pinions are usually made of a stronger material than the mating gear or else the teeth are shrouded. Any error due to this assumption will evidently be on the safe side.

II. The accuracy of this assumption depends chiefly upon the rigidity of the rim of the gear. The internal stress in each arm is also influenced by stresses due to unequal shrinkage in cooling. It is therefore advisable to limit the allowable fiber stress in the arms due to the load to about 7/10 that in the teeth.

III. This condition cannot exist unless the arms are pin connected to a rigid rim, but as the assumption is in common use in similar cases and seems to afford the only direct means of attacking the problem it may be considered as allowable.

IV. Arms of these proportions are very commonly used for spur gears of ordinary sizes. The formulas here derived may be adapted to other forms of section by making a suitable change in the value of the constant.

V. 15 degrees involute cut teeth represent the best modern practice.

The following notation is used:

N = number of teeth in gear.

p = circular pitch of gear in inches.

$d.p.$ = diametral pitch of gear.

f = width of face of gear in inches.

$k = \frac{f}{p}$ = factor for width of face.

y = strength factor for teeth given by Lewis. (For 15 degrees involute cut teeth $y = 0.124 - \frac{0.684}{N}$.)

n = number of arms in wheel.

h = width of each arm when prolonged to center of wheel.

b = thickness of each arm prolonged to pitch line. (When the usual taper of ⅛ inch per foot per side is used, $h_1 = h - \frac{D}{32}$.)

Then in terms of diametral pitch;

$$h = \frac{5.639}{d.p.} \sqrt[3]{y N^2 \frac{k}{n}}.$$

For normal gears having 6 arms and a width of face equal 3 times the circular pitch we have,

$$h = 1.425\, p \sqrt[3]{y N} = \frac{4.476}{d.p.} \sqrt[3]{y N}.$$

The accompanying curves show values of h and h_1 for normal gears having from 50 to 200 teeth of from 1¼ to 6 diametral pitch. The full lines give values of h, and the broken lines the corresponding values of h_1. It will be noted that the values of h_1 change but little throughout the entire range of number of teeth. This indicates the possibility of an empiric formula giving values for the width of arm at the pitch line in terms of the pitch and independent of the diameter of the gear. Taking average values:

$$h_1 = 2.23\, p = \frac{7}{d.p.}.$$

This affords a very ready means of determining the size of arms for a gear of normal proportions. For gears having more or less than 6 arms or unusual widths of face the values may be obtained by means of the equations.

Although 6 arms are used in most gears, it is probable that this number cannot be used in a gear having less than 50 teeth, and it may be considered better practice to use 4 or 5 arms when the number of teeth is less than 60. Gears having less than 35 to 40 teeth should have solid webs. In case of very large gears it is probable that more than 6 arms will be needed to give proper rigidity to the rim.

Special Auto Steel

By Thos. J. Fay*

The introduction to this subject is necessarily abridged owing to lack of time and space, and with a view of presenting all the useful information the matter of auto steel will be taken up at once.

The notes, statements and conclusions which will be presented are based upon data from a large number of tests. The reliability of all these tests is shown in that the steel was purchased, tested, machined, put into service, and the results of service were noted in nearly every case by the author. In some of the cases where the products were found in service the degree of satisfaction was noted and tests were made after service.

At all events the steel mill had nothing to do with the tests. The service was regular automobile work of the most exacting order in high-priced, high-powered cars, excepting in one or two instances. It is the firm belief of the author that tests of steel to be of value should include the service test.

*Abstract of a paper presented at the Indianapolis meeting of the American Society of Mechanical Engineers, May, 1907.

Before entering into a detailed discussion of the relative value of the several products, it may be well to set forth the results:

a Carbon steel for crank shafts, gears, axles, distance rods, and springs, as well as some of the less responsible parts, showed many failures in service.

b Not a single part made of chrome nickel steel ever used by the author failed in service, although some of the chrome nickel steel was not up to the high standard of quality.

c Puddle iron for mud guards, lamp brackets, and like parts is a superior product; moreover, carbon steel does not render so efficient service.

d So called puddle steel, steel below 0.10 per cent. carbon, as usually produced, does not serve as a good substitute for the fine grades of iron mentioned above.

e Die forgings of alloy steel make the use of alloy steel quite possible for even low-priced cars.

f Designs must take into account the fact that alloy steel is to be used, or the cost of machining will be excessive.

Mechanical engineers are as a rule fully alive to the fact that in fashioning even ordinary steel into the shape to make a serviceable device, the steel will lend itself to the process more or less readily depending upon the carbides contained in the product. The influences can be stated briefly as follows:

a Carbon under 0.16 per cent. is below the point at which steel will harden noticeably upon subjection to heat and then cooling in oil or water.

b While sulphur can be as high as 0.10 per cent. in mild steel for cold working, it is a fact that the presence of carbon, chromium, and nickel demands a decided reduction in the sulphur content.

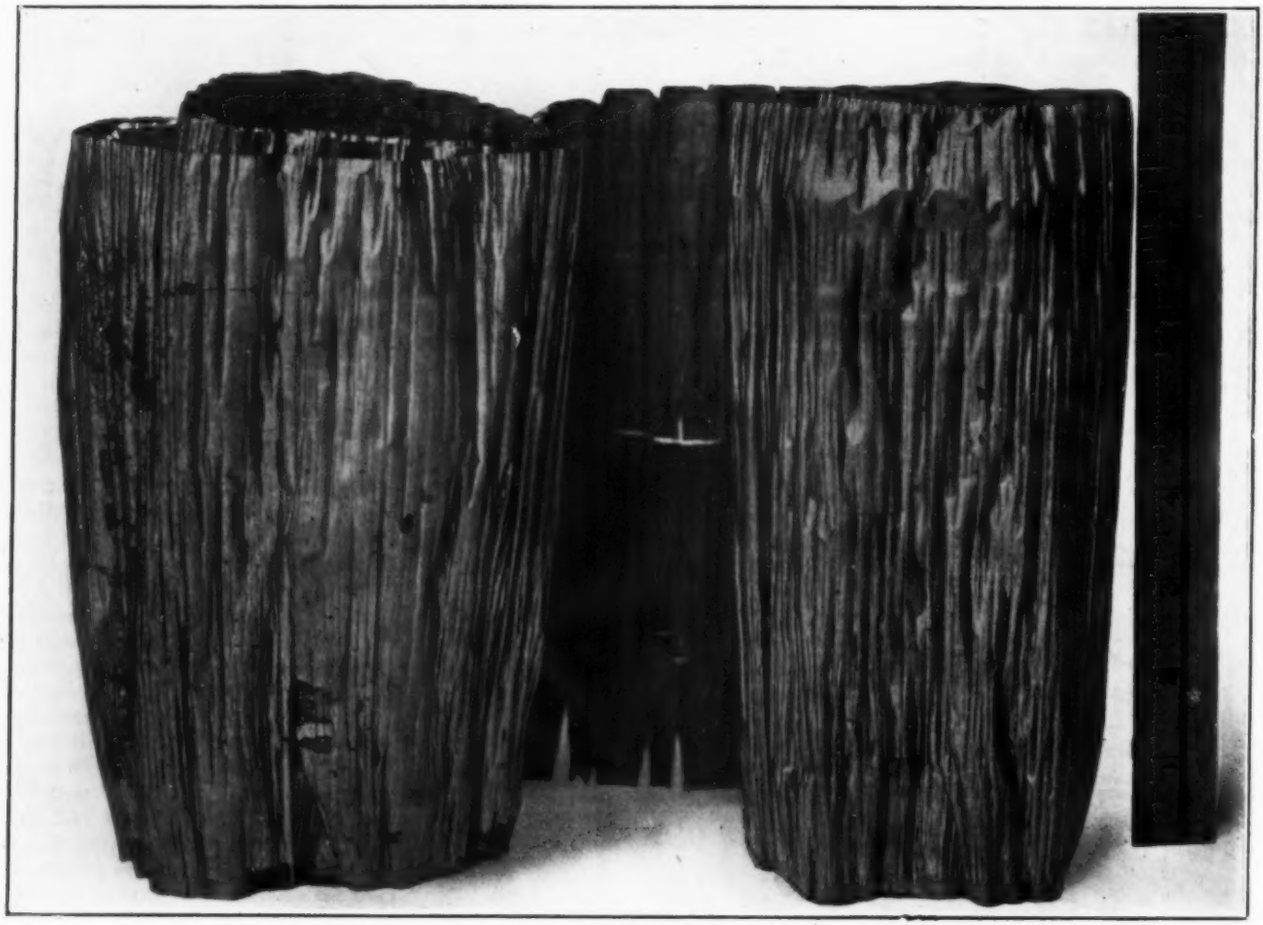


FIG. 1. A CHIP FROM KRUPP GUN STEEL

c Phosphorus is not desirable in steel for important service, but ordinary bessemer products do contain phosphorus up to 0.10 per cent., and this kind of steel serves for many useful purposes. Phosphorus very far below this stated amount would render alloy steel useless.

d Silicon can vary considerably in ordinary steel, but its presence in alloy steel is detrimental and should be limited.

e The percentage of manganese is often run up in ordinary steel to compensate for a low percentage of carbon, the object being to satisfy

the specifications for physical properties. In alloy steel this "doctoring" process is not practicable.

f Nickel in nickel steel has well defined and useful ranges, but its relation to carbon must be closely maintained.

g Chromium has a marked effect upon the properties of steel and with the known mixtures can range as low as 0.50 per cent. and as high as 3.50 per cent., but the relation of both carbon and nickel must be maintained within narrow limits.

h Vanadium as an intensifier is even more pronounced than chromium, but both chromium and nickel can be present if the quantities are properly regulated.

i Wolfram is a peculiar intensifier and changes the character of the steel by changing the carbon relation.

j Copper until recently was considered as of little or no value, but is now used in the finest grades of ball-bearing steel, and is often found in "fire-box steel."

Other elements, as boron, uranium, titanium, platinum, and other possible alloying metals will not be discussed because their uses are not defined. Later research may develop more satisfactory results than are now obtainable.

Having thus set down the composition of steel products that are used more or less advantageously and knowing their results, the next important consideration is to fix the limits of the undesirable carbides.

PHOSPHORUS

Ordinary bessemer steel, between	0.08	and 0.10
Ordinary structural steel, between	0.06	and 0.08
Specification structural steel, between	0.04	and 0.06
Inferior alloy steel, between	0.02	and 0.04
Good alloy steel, between	0.015	and 0.02
Superior alloy steel, between	0.010	and 0.015

SULPHUR

Ordinary bessemer steel, between	0.08	and 0.10
Ordinary siemens steel, between	0.06	and 0.08
Ordinary structural steel, between	0.04	and 0.06
Good boiler plates, inferior alloy steel	0.02	and 0.04
Good alloy, between	0.015	and 0.02
Superior alloy steel, between	0.010	and 0.015

SILICON

Superior alloy steel, between	0.10	and 0.20
Good alloy steel, between	0.20	and 0.30
Inferior alloy steel, between	0.30	and 0.40

MANGANESE

Very soft alloy steel, between	0.10	and 0.20
Very soft alloy steel, between	0.20	and 0.30
Soft to medium alloy steel, between	0.30	and 0.40
Medium alloy steel, between	0.40	and 0.50
Fairly hard alloy steel, between	0.50	and 0.60
Hard alloy steel, between	0.60	and 0.70

The range of all these carbides is quite a different matter from the consideration of the range of the intensifier, unless it be said that manganese plays a small part, although the results with low manganese are more satisfactory on the whole than when manganese is used as an intensifier. Taking up the intensifiers in detail, it can be safely said that carbon becomes a very disconcerting element, unless held within narrow limits.

That the ranges it is possible to employ may be by far greater than these values is scarcely to be doubted, but beyond the limits defined by experience the question becomes purely academic. It is the aim in this paper to consider things from the point of view of the executive engineer.

Nickel is of the utmost importance in alloy steel, but nickel without chromium, or chromium and vanadium, is very inferior in comparison with the more complex alloys. While it may be true that nickel alone checks the segregation and acts on the cementing materials so as to bind the elements more closely, yet nickel not only fails to prevent blow holes, but they are more prevalent in nickel steel than in carbon steel. The production of nickel steel even with greatest care and extraordinary skill, is attended by many vicissitudes, and users of this product are ever confronted by a possibility of hidden flaws. Nickel besides affecting the melting carbides, raises the elastic limit relation to the tensile strength, but in comparison with chrome nickel steel, the elevation of the elastic limit in nickel steel is not marked. Nickel also affords immunity from "extending cracks" but unfortunately *it is very apt to conceal them.*

Chromium combined with nickel is decidedly advantageous because the effect on the melting carbides or on the eutectic more likely, is not in opposition to the effect of nickel, nor is the influence identical. It follows then that the carbides are more closely bound in this cementing relation when chromium is present, than can be the case if there is nickel and no chromium.

The relation of the elastic limit to the ultimate strength is vastly changed by the use of chromium; moreover, this change of relation is not at the expense of the elongation to any marked extent. But the presence in any considerable amount of some of the carbides, as silicon, sulphur, phosphorus, and manganese, is to be deplored, for then the elongation is noticeably a diminished factor, and the ability of the product to withsand severe shock falls off in a most disconcerting way.

Vanadium seems to supplant nickel, and when combined with it reduces the need of chromium to some extent. This element influences the eutectic in its own way, besides supplanting nickel absolutely and chromium in part for certain grades of steel. The specific value of vanadium is due to the ability of this element to thwart constitutional segregation by combining with carbon rather than by altering the melting point of the carbides. This explains the added value when a small increment of vanadium is introduced in conjunction with nickel and chromium. Vanadium is also important because it tends to safety, in that "metal fag" is much deferred, and it is also found that steel containing vanadium, with or without nickel, is free from "crack and tension" tendencies. Moreover, vanadium steel is not so apt to have blow holes; although for that matter chrome-nickel steel is free from such imperfections to a marked degree.

The carbon content must be controlled with vanadium to a greater extent than with either nickel or chromium, and an increase in vanadium should follow a decrease in carbon, otherwise the product might prove too hard to machine and have other faults. In this connection it might be well to point out the reasons why alloy steel is discriminated against:

a It costs more per pound than carbon-steel products;

b It resists machining on account of its tenacity.

The great problem in automobile engineering at the present time is not to substitute for alloy steel or to experiment with all possible mixtures, but to find some one product that will serve for the purpose, which can be fashioned readily and quickly. The price of this product must be reasonable, but it does not have to compete with bessemer steel for two reasons, viz.:

a Bessemer steel will not serve the purpose in any event.

b Alloy steel has fully four times the elastic limit and all the desirable advantages, though it should cost four times as much as bessemer steel.

Attention is here called to the cuts, Figs. 1 to 9 inclusive, each one of which represents a feature of the steel problem, as it affects the automoible.

Illustrative of the advantageous quali-

RELATIONS OF NICKEL TO OTHER METALS.

NICKEL.		CHROMIUM.		VANADIUM.		MANGANESE.		CARBON.	
from	to	from	to	from	to	from	to	from	to
2.00	2.50	0.60	0.70					0.30	0.40
3.00	3.50	1.40	1.60					0.25	0.30
4.50	6.00	1.50	1.70					0.20	0.25
10.00	12.00	1.75	2.25					0.40	0.50
22.00	26.00	2.25	3.25					0.50	0.60
30.00	32.00							0.50	0.60
22.00	26.00							0.40	0.50
10.00	12.00							0.30	0.40
4.50	6.00							0.25	0.30
2.50	3.50							0.22	0.28
1.00	1.50							0.20	0.25
2.50	3.50			0.25	0.30			0.20	0.25
1.15	1.80	1.00	1.30			0.90	1.10	0.20	0.25
		1.40	1.60			0.90	1.10	0.20	0.30

ties of chrome nickel steel, reference will be made to one particular application that proved to be especially profitable.

Fig. 1 shows a chip from L. B. R. Krupp gun steel: Width of cut, 8¼ inches; thickness of cut, 0.005 inch; length of specimen, 10½ feet; the tensile strength of L. B. R. steel is 70,000 pounds per square inch.

This long unbroken length of a cut from a gun barrel, as thin as it is, illustrates adequately the fact that steel with a high elongation and very low in the carbides can be machined readily and admits of taking cuts of great or small thickness depending upon the exigencies of the situation.

The half-tones, Figs. 2 and 3, give two views of one specimen of this steel, one of which shows one-half with a split developed by bending over the piece 180 degrees and hammering down flat, while the second picture shows the other half of the same specimen, bent over 180 degrees and hammered down flat, without developing a sign of a crack at all. The difference is due to the fact that one-half was annealed and the other was not, The pieces were made into the shape shown by flattening a 1¼-inch round bar down to a ¼-inch flat sheet, at a temperature of about 950 degrees C. under a steam hammer. The importance of annealing is apparent.

Special Nickel Steel

Special nickel steel subjected to heat treatment acts as follows:

a Heated to 900 degrees C. and reduced in diameter from 1¼ inch to 1 inch, allowed to cool, was found to be soft.

b Heated to 900 degrees C., quenched in water and found to be "file hard."

c Annealed at 570 degrees C. for one hour and rendered soft by the process.

d Heated to 900 degrees C. it can be flattened out to ¼-inch thickness without showing frayed edges, see Fig. 4.

It is hardly possible to repeat this process with an inferior alloy steel containing over 0.020 phosphorus, and 0.030 sulphur, high manganese, or carbon above 0.25 per cent., see Fig. 5. Notwithstanding the fact that this carbon steel was a fine specification product, it fractured at a tool mark in the act of shaping, and the fracture showed a large crystalline structure. Fig 6 shows a long chip cut at a red heat. It was taken from a built-up crank shaft of E. F. 60-0 Krupp steel in the Ellsworth shop, under the direction of the author, using a 30-inch lathe specially fitted up to handle this work.

The data were as follows:

Mean diameter of work, 8 inches; circumference, 25.1328 inches.

Speed of spindle, 48 revolutions per minute; hence,

$$\frac{48 \times 25.1328}{12} = 100.53 \text{ feet per minute.}$$

The tool held its own on this work for about four hours, but at a speed of 20 revolutions per minute of the spindle it would not do the work satisfactorily.

Fig, 9 is offered to show the shape of tool that seems to do the most work without turning its edge or developing rupture. The setting of the tool is of the utmost importance, and the tool post must be particularly rigid. As will be observed, the cutting edge intercepts the metal at a point 1/20 of the diameter of the work above the axle center. When the cutting edge intercepts the work near or below the center, trouble ensues.

Of the most important matters, the ability of the metal to *withstand shock loads without rupture is paramount,* and an actual collision should only result in the deformation of the parts, but without rupture. A 60-horse-power Mercedes racing car on the Vanderbilt course last fall collided with a telegraph pole. The author examined every part without discovering a broken steel member, although not one was straight, and most of them were greatly distorted.

This car was of alloy steel in the following principal parts:

Crank shaft	E. F. 60-0 Krupp
Distance rods	E. F. 60-0 Krupp
Axles	E. F. 60-0 Krupp
Gears	E. F. 60-0 Krupp
Cardan shaft	E. F. 60-0 Krupp
Jack shaft	E. F. 60-0 Krupp
Side frames	C. 46-0 Krupp

The ability of this metal to withstand shock was proved in this instance.

Fig. 7 shows a Krupp chrome nickel steel front axle bent until the ends touched without fracture. After release the ends opened as shown by the half-tone. Fig. 8 shows another part of Krupp nickel steel, which was deeply notched and bent to 180 degrees without fracture. Its normal physical properties are:

Tensile strength	78,090 pounds square inch
Elastic limit	44,237 pounds square inch
Extension	25.8 per cent.
Contraction	58.2 per cent.

Diameter of test proof ½ inch, 40 carbon, A. O. H. steel, Krupp.

Carbon steel would seem desirable if it can sustain such severe shock loads, as this test indicates, and it can without question, if it is a low sulphur, low phosphorus, acid siemens product.

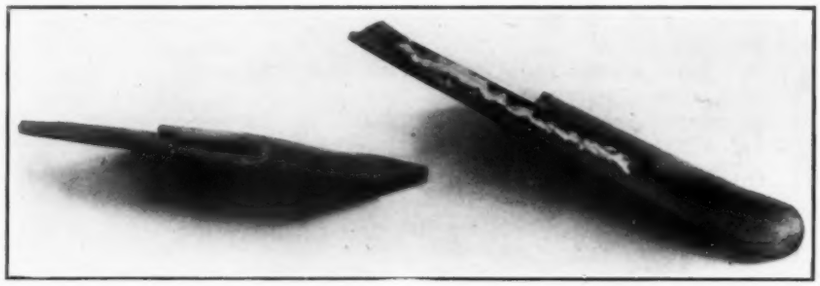


FIG. 2 KRUPP NICKEL STEEL AFTER FORGING FIG. 3

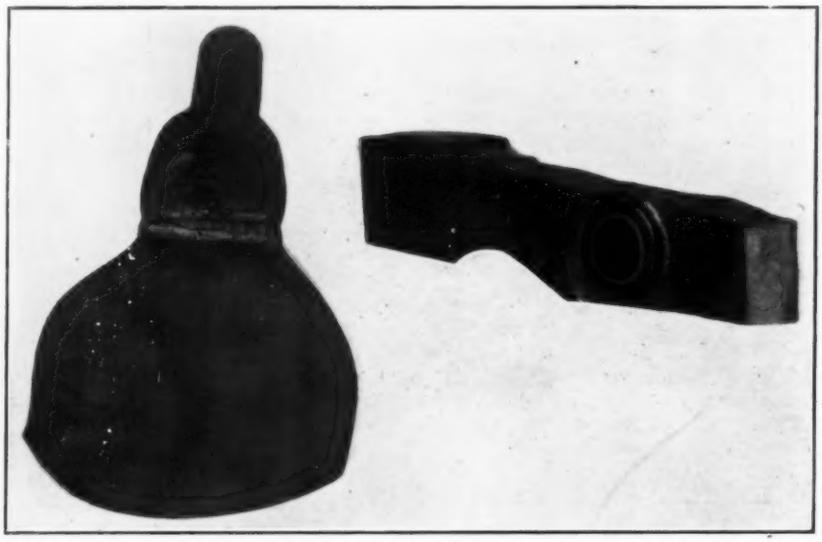


FIG. 4. A NICKEL-STEEL FORGING FIG. 5. A CARBON-STEEL FORGING

From laboratory tests it would seem that this can be done, but actual attempts to duplicate these excellent results in practice end in defeat every time, for the following reasons:

a The steel is very often rendered crystalline in forging;

b The steel is sometimes burnt in forging;

c Notched bar tests disclose the inability of this product to sever in parts that, when designed, have shoulders, flanges, holes, or any irregularities of shape, that approximate a notch.

The notched bar tests by "Brinell" were given as follows and are offered as evidence of this fact.

No.	Blows.	Footpounds.	Remarks.	Material.
5	4	130	Notched.	0.44 car'n steel
4	5	195	Notched.	0.34 car'n steel

As will be observed, the impact in footpounds was very much less, and notwithstanding the rupture followed with 4 and 5 blows, respectively.

This phenomenon of carbon steel is probably too well understood by engineers in general to require more than the mention here given, but automobile engineers have learned by sad experience, that the impact "test" in the "laboratory" is as "varioloid" to "smallpox," as it were, if the automobile is substituted for the conventional impact test. If then alloy steel is the product that will sustain shock loads, it is the steel to use for all parts that must absorb such shocks. The one remaining

FIG. 6. A CHIP OF CHROME NICKEL STEEL

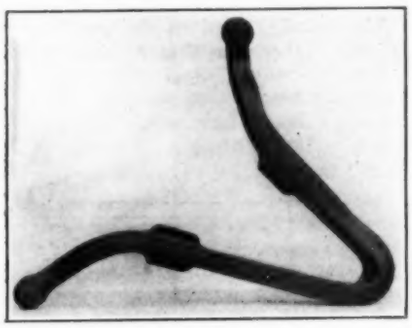


FIG. 7. A FRONT AXLE OF KRUPP CHROME NICKEL STEEL

question is that of the "mixture" affording the greatest ease of working and the greatest factor of endurance.

Machining Qualities

Normal steel, no matter what its composition, will resist machining dependent more or less upon a coefficient of hardness that is not wholly represented by the tensile strength of the steel itself, but the relative values based on tensile strength would approximate the true situation if the hardness of the cutter could be made proportionate to the hardness of the material to be cut in a constant ratio.

For the purpose of this paper the coefficient of hardness can be set down as indicated by the tensile strength, assuming that the tools used will be strong enough to handle the hardest of steel to be considered. On the other hand, the value of the steel is not represented by the tensile strength, but it can be represented by a coefficient of usefulness deduced as follows:

$f = (T.S. \times E.L.)$ Ex. = coefficient of usefulness.

This figure of merit takes into account not only the original strength of the steel, but its endurance and on this account it is a better method of comparison than the consideration of relative abstract values as the values in Table I will show.

Before going more deeply into the question of merit, it may not be amiss to repeat Professor Unwin's view about "Elongation," since merit is largely a matter of elongation. Professor Unwin points out, and no doubt the audience fully understands the factor elongation has two components:

a The elongation throughout the length of the test proof, that is, between enlargements;

b The local stretch and contraction of the section during the final stages.

While it is plain that the general elongation is independent of the diameter of the proof, it is equally plain that the local stretch varies with the sectional area of the proof, and it follows that no comparison between tests can be of any great value unless the diameter as well as the length of the proofs are the same.

The coefficient of hardness "*h*" (see Table 1) of steel must be taken into account for two reasons:

a The cost of machining increases with it,

b Bearing surfaces are dependent upon it.

When the coefficient of hardness is greater for carbon steel, that in itself constitutes a good reason for substituting alloy steel, but the figure of merit must also be taken into account. It is not easy to show this on paper, but by putting down the values of hardness it may be possible to advance a step and show by abstract methods, just when alloy steel should supersede carbon steel. But it would be a fallacy to assume that the tensile strength alone, or the elastic limit alone, or both combined, will govern this process, although it is admitted that the tensile strength does represent the hardness of steel in a general way.

It was by watching a tool that the author discovered that steel so hard that the tool bounced off *could be cut at a higher speed with the same tool,* and investigation along this line led to the belief that increasing the elongation without a decrease in tensile strength brings further advantages. It is believed that this is the

No.	Product.	Coefficients. Hardness "h"	Coefficients. Usefulness "p"	Process.	Used For
1	Chrome nickel steel			F	Change gears
2	" " "			F	Change gears
3	" " "	19,226	2,160,280	F	Change gears
4	" " "	35,986	2,024,250	G	Change gears
5	" " "	11,614	3,384,250	E	Change gears
6	" " "	7,318	3,942,000	E	Testing
7	" " "	9,752	5,158,900	E	Crank-shafts
8	" " "	6,674	4,513,600	D	Brake drums
9	" " "	8,260	4,371,500	E	Daimler parts
10	" " "			E	Change gears
11	High carbon steel			G	Motor valves
12	" " "	44,604	1,024,680	G	Motor valves
13	Mild carbon steel	4,238	1,312,960	B	Crank-shaft
14	Chrome nickel steel				Change gears
15	" " "	10,125	5,832,000	E	Crank-shafts
16	" " "	25,845	3,127,300	F + G	Crank-shafts
17	" " "	7,319	3,910,000	E	Crank-shafts
18	" " wolfram steel	28,571	3,150,000	F + G	Testing
19	" " steel	24,263	2,285,029	F + G	Side frames
20	Nickel steel	5,774	3,905,200	E	Crank-shafts
21	Chrome nickel vanadium steel	9,500	6,422,000	F	Rifles
22	" " wolfram steel				Springs
23	" " " "				Springs
24	Medium carbon steel	4,125	2,239,550	A	Crank-shaft
25	" " "			C	Wheel hubs
26	" " "			C	Side levers
27	" " "			C	Cardan shaft
28	" " "	6,179	3,699,500	C + D	Connecti'g-rod
29	Chrome nickel steel	8,192	3,893,480	E + F	Testing
30	Nickel steel	5,852	3,699,500	D	Jack shaft
31	Chrome nickel steel	126,488	728,400	G	Testing
32	Nickel steel	7,090	3,432,000	E	Crank-shaft
33	High nickel steel	3,133	7,667,000	C	Motor valves
34	Medium carbon steel			C	Spring link
35	" " "			C	Steering arm
36	" " "			C	Bevel drive
37	" " "	6,689	2,414,900	C	Change gears
38	Chrome nickel steel	20,060	1,518,367	F + G	Ball bearings
39	" " "	10,832	2,437,380	F	Ball bearings
40	" " "	15,216	2,772,900	F + G	Ball bearings
41	" " "	14,274	7,550,900	F	Special forging
42					

TABLE I. APPROXIMATION OF RELATIVE VALUES OF AUTO STEEL.

most important detail connected with the difficult work of fashioning alloy-steel parts, and the coefficient of hardness is devised, taking into account that the metal is *heated* by the tool, thus rendering it *easier for the tool to do the work.*

If the metal is short, i.e., does not possess a good elongation, the tool clatters, and it cannot be made to take hold, so that the heating process then cannot be taken advantage of. It was a great surprise to the machinist, who was unable to keep a "Novo" tool sharp at the speed he was operating, and when he was told to double the speed, found that the same tool on the same piece in the same lathe held its edge for several hours.

The coefficient of hardness, then, takes into account this condition to an approximate extent, of course, because absolute data on this subject are difficult to obtain. But if the metal is to be taken off cold, the coefficient of hardness must be readily represented by the tensile strength, as at first suggested.

The true coefficient of hardness, taking into account high-speed cutting—hot work—is found as follows:

$C = \frac{T.S. + E.L.}{Ex.}$ coefficient of hardness,

in which:

$T.S.$ = tensile strength in pounds per square inch;

$E.L.$ = elastic limit in pounds per square inch;

$Ex.$ = elongation in per cent. in 2 inches on ½-inch diameter test proof.

This equation is empirical, but timing tools and observing performances and the knowledge of the value of the steel in each case support the contention that its basic principle is worthy of esteem.

Now comes the more important point in relation to alloy steel, which spells success or failure in almost every instance.

To illustrate this point it will be necessary to call attention to the practice steel makers have of "doctoring" their products to make them more attractive to purchasers. The doctoring process may be that of oil quenching and subsequent annealing, or it may be some other process. In any event the result is that in many cases the tensile strength and elastic limit are increased at the expense of the elongation.

True, the elongation may be held high enough to serve the purpose, but the cost of machining is by such a process enormously increased, while the factor of merit, or coefficient of usefulness of the steel is, as a rule, decreased.

It is possible to formulate a rule that will show the extent of damage. Such a process is as follows:

"For a given product, the coefficient of hardness—difficulty to machine—increases inversely as the square of the elongation."

This rule seems to hold for any treatment that can be given any one specimen of steel and it proves conclusively, if the rule obtains, that the steel mill should reverse its practice and charge more for high elongation, instead of charging for high elastic limit and the lowest acceptable elongation.

Of course, in the case of the E. F. 60-0 Krupp steel, or for any other product, the coefficient of hardness of the steel must be lower than the coefficient of hardness of the cutter by a considerable margin, else the edge of the cutter will be turned. The

FIG. 8. KRUPP NICKEL STEEL NOTCHED AND BENT 180 DEGREES

endeavor has been to approximate these values and fix upon a relation, but the matter will require much further study; for, as may be inferred, the problem is complex.

The most that can be said with certainty at the present moment is that a coefficient of hardness of about 15,000 can be handled commercially, using "Novo," "Krupp," "Bischoff" or "Jessup" special grades of tool steel, costing from 50 cents to $1 per pound. There may be other brands of tool steel suitable for the work, but those tried dulled on a far lower hardness than 15,000.

The best that can be suggested at this time by way of clearing up this point is to fix a relation between the coefficient of hardness "*h*," as given in the Table 1, and a process index, also given in the same table.

We all know in a more or less exact way just what the machine tools will do, and an attempt will therefore be made to refer to the matter in terms of the ability of machine tools. Of course some machinists excel and can do much better, but the square roots of mean squares must be taken as true ability.

The Machining Process

In Table 1 one column is headed "Process" and a reference letter is placed in that column opposite each specimen of steel referred to. The reference letters are given meanings as follows:

A machines without difficulty in ordinary lathes or other tools using carbon-steel cutters of the ordinary quality;

B machines only with difficulty with tools suitable for *A*;

C machines in ordinary machine tools using a middle quality of tool steel;

D machines with great difficulty under *C* conditions;

E machines with ordinary machine tools using the finest quality of tool-steel cutters;

F can only be worked in large, heavy machine tools using the finest quality of cutting steel;

G can only be ground; too hard to be cut by any known grade of tool steel, unless with the greatest difficulty.

Products that are so hard as to resist all but the grinder can, as a rule, be annealed, and may then become softer, so as to take a new rating, but the dominant idea here is to rate steel as it comes from the mill, since annealing takes time and has its own set of risks, which become double when alloy steel is to be operated upon

As regards machine tools for handling alloy steel, there is much to be done, but the author finds by actual trial, that heavy tools are preferable in every way, as for illustration:

Old practice	New practice
20-inch lathe	30-inch lathe
16-inch lathe	20-inch lathe
12-inch lathe	16-inch lathe

The spindle speed of the new heavy lathe is higher than that which obtained

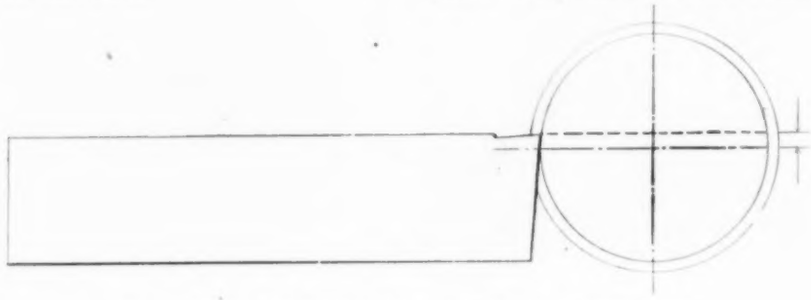


FIG. 9. SHAPE AND SETTING OF A TOOL FOR HIGH-SPEED WORK

for the old smaller lathe, and the cuts are taken heavy enough to bring the turnings off at a "dull red heat."

With chrome nickel steel, this result comes if a cut ⅝ inch wide by 3/16 inch thick is taken off at a speed of from 90 to 100 feet per minute. The coefficient of hardness of the steel in this case is:

$$\frac{110{,}000 + 90{,}000}{16} = 12{,}500,$$

and the tool steel is "Novo," size of tools ¾x2 inches, air-cooled from a temperature of 1400 degrees Centigrade, in a strong air blast from a blower. The tool looks as shown in Fig. 9, and as will be observed, it is backed off but slightly. The tool post must be rigid and strong.

The working of alloy steel will be briefly considered:

a Die forging is the cheapest method possible, no matter what the cost of the dies;

b Lathe turning is the most likely to give the best results at the lowest cost per pound of metal removed;

c Special annealing facilities pay for themselves in even a few days;

d A Le Chatelier or equally good pyrometer and a good muffle furnace are indispensable;

e Hardening facilities should be complete and up to date;

f Compromising with tool steel is a waste of time;

g "Novo" steel drills are far superior to carbon steel drills for drilling alloy steel;

h Milling does not pay and should be eliminated in the design as far as possible;

i Shaper work should be cut out;

j Planers do not seem to serve very well in alloy steel work;

k A thousand dollars worth of redesigning will often save a hundred thousand dollars worth of work.

In concluding the question of the machining process it may be interesting to state that the author has developed a lathe —30-inch swing—with a 36x42-inch power feed platen, on which much of the work is set and is faced by means of fly cutters on the face plate of the lathe. The work can be fed into the cutter or crosswise, as the case may be. The same type of lathe is fitted with "boring bars" for boring work, and work in centers or chucked work can also be handled. This type of tool then supersedes the boring machines, the miller, shaper, and planer. The rigidity, accuracy, and nimbleness of a lathe is utilized while the cost of fixed tools as end mills, straddle mills, and the like, is eliminated, which is a very serious item in working alloy steel since carbon steel mills will not hold an edge, and high-speed steel mills cost over much, and do not last indefinitely.

Forgings

One remaining question that can be discussed, is that of "forging" aside from forgings in dies, and will receive but bare mention.

In the main, steel makers recommend that parts, if of alloy steel, be worked from normal stock, and that heating as in forging work, be avoided. As a general proposition chrome nickel steel forgings are just about twice the hardness of the same product in the normal state, and steel producers always must consider that users of steel in any attempt at annealing may fail to observe the requisites, although it is admitted that a properly conducted annealing process will restore steel to its original hardness which is, of course, a softer state than that which obtains if annealing is neglected.

Figs. 2 and 3 show the benefits to be derived by annealing, and the gains are twofold:

a The forgings machine more expeditiously;

b The parts are freed from internal strains and will serve their purpose more perfectly.

It is not uncommon to observe smiths who after forging parts raise the temperature to some high heat and then impede the cooling off process more or less. This is called annealing by them, but in most cases the product—chrome nickel steel—is rendered unmanageable by this process, and the microstructure of the steel so treated looks more unpromising. Forgings can be rendered soft by annealing just as expeditiously by the user as by the steel maker, but for the same results equal care must be exercised. The best way, perhaps, is to have the annealing process conducted as a separate operation after the forging work is completed and the forgings are cold.

If the forging work is not properly done, the annealing process will reflect its imperfections and since so much depends upon it, the annealing should be done by someone beside the person who does the forging. Annealing then serves as a check.

Friederich Krupp, and Essen-Ruhr, in a communication dated November 24, 1905, state their views on the subject, as follows:

"Steel E F 60-0 is a hard material and should therefore be treated with care during the heating. It is to be slowly and uniformly heated in a wood fire and after it has been heated in this way to such a degree that it cannot be touched anywhere, it is to be heated in the furnace to forging heat (1050 degrees Centigrade) but not before. The forging must not be continued for too long a time, and is to be interrupted at *red heat*. If necessary, the steel is to be reheated.

"The cooling down of the material after forging must take pace in the same slow and uniform manner as the heating and forging, for this purpose the forged pieces are to be placed in ashes and left therein, until they have cooled down.

"The annealing of the forgings is to be performed at a temperature of about 630 degrees Centigrade, the pieces, as a rule, being exposed for about two hours to this temperature. In the case of very thin pieces a shorter time of annealing will do. The heating and cooling down is to be done slowly, the same as in the case of the forging."

For the best results, a muffle furnace equipped with a pyrometer must be resorted to, because with alloy steel, definite temperatures must be observed.

There is one other point in relation to this question, i.e., no matter how carefully the forging and subsequent annealing is done, the forgings will be over-hard if the steel is inferior, not in comparison with carbon steel, *but as alloy steel*. It is not easy to understand why a slight difference in the carbides will make such a great difference in the hardness of annealed forgings, even when the process is very carefully conducted. In any case the fact remains and to show how marked the influence is, it may be pointed out that product 9, Table 1, is rendered much harder by forging, than the product 15 of the same table. The main difference between these products is in the phosphorus and sulphur, although product 15 has a higher nickel content, and is lower in carbon. But the author has observed that the annealing process is much more successful with steel of low sulphur and phosphorus, than it is, if these carbides are high, even in cases holding identical carbon, nickel and chrome.

As a matter of fact the product chrome nickel steel, if it is to be forged and it must be to build motor cars, will scarcely serve, excepting to greatly hamper the work, unless the chemical composition is held within narrow limits. The best product is that showing *the nearest approach to pure iron*, after subtracting chromium, nickel and carbon.

In conclusion it may be said the alloy steel question is an evidence of the fact that, taken as a whole, the modern automobile bears testimony to one of the greatest triumphs of metallurgy and mechanics, in alliance with all the means of exact science.

Jewish Metal Workers

Commenting upon the capabilities and possibilities of the Russian Jew, the *American Hebrew* says that most of those who come over here are qualified to rank as skilled workers in brass, copper and bronze. The most evident example of this service is the artificer of brass and copper, the Russian metal worker who can be found in certain portions of the East Side of New York City.

The working of bronze and copper and brass into utensils and ornaments is one of the most common industries of the Russian villager, who, engaged for years in the industry, has reached such a standard in his work as compares more than favorably with that of other nationalities. Drinking vessels, teapots, samovars, candlesticks are turned out with the most artistic workmanship by the East Side Jew.

The metal utensils and instruments which he makes find their way into many a home in New York City and country, the inmates of which are accustomed to regard the Jew as a native of the parasitic industries, trading, peddling, commerce, and who would be astounded if they were told that such finished artistic products were the work of Russian Jews, speaking an unintelligible Jargon, whom they regard as an ignorant alien.

Boring Bars and Cutters

By E. A. Dixie

On account of the enormous amount of boring done at the various works of the Link-Belt Company, and the excellent system to which boring has been reduced by them, a description of their methods will be of interest to many having similar work to perform.

Roughing Cutters

All roughing cutters are of high-speed steel. Owing to the heavy cuts and feeds, and the inability to obtain or retain uniformity in cutting angles and shape of the nose with single-ended cutters of flat section, these were abandoned in favor of cutters made from steel of square section ground in a Sellers tool-grinding machine, the same as regular turning tools. With these cutters it is found possible to rough bore steel wheels at the same speed, feed and depth of cut used in turning.

For the roughing cutters high-speed steel from ¼ to ¾ inch square is used. The steel can be bought in bars ready for use, or lathe tools that have become too short in service can be drawn out under the hammer to the desired sizes.

Cutters made from the treated bar stock are produced in the following manner: The bar is marked off in lengths equal to the length of two cutters. Two notches are ground in the bar at the marks; these form roughly the finished nose, leaving little grinding to complete the cutters. The bar is then broken and a finished cutter nose ground on each end of the bar, as shown in Fig. 1. The double-ended cutter is then nicked in the center on an emery wheel and broken in two, which finishes the work.

Cast-iron holders were made to handle the square roughing cutters in the Sellers tool grinder. These holders are clamped to the tool holder of the machine.

While high-speed steel was found to be all right for roughing cutters, it would not hold its size through long bores. For this reason carbon steel is used for finishing cutters. A test was run on nine brands of foreign and domestic carbon steels. The test was made on cast-iron bushings 9 inches long, 3½ inches bore. The depth of cut was 1/64 inch and the feed 0.0715 inch per revolution. The speed was gradually increased until the cutter began to fail. Of the nine steels tested, four finished good holes to plug gage at a speed of 100 feet per minute with the aforementioned depth of cut and feed. Of the four steels, one was selected and is being run at 60 feet per minute on cast iron with 1/64-inch depth of cut and 0.0812 inch feed per revolution.

Double-end Cutters

Double-end boring cutters, shown in Fig. 2, are made from both high-speed and carbon steels. These cutters are of standard sections 3/16x1 inch, 5/16x1⅛ inches and ⅜x1½ inches. These cutters are made from bar stock or from old high-speed tools drawn down to size. The limits of variation allowed on the bar stock are: Not more than 0.005 inch over or 0.01 inch under size.

The cutters are cut to length and rough ground on a fixture used in the surface grinder. For lipping the cutters a Sellers tool-grinding machine is used. The cutter is held in the tool holder and ground in the same manner as a lathe tool.

For rough grinding, an emery wheel M grade 30 grain is used.

With the object of eliminating hand work as much as possible, an attachment was designed for a No. 1 Brown & Sharpe

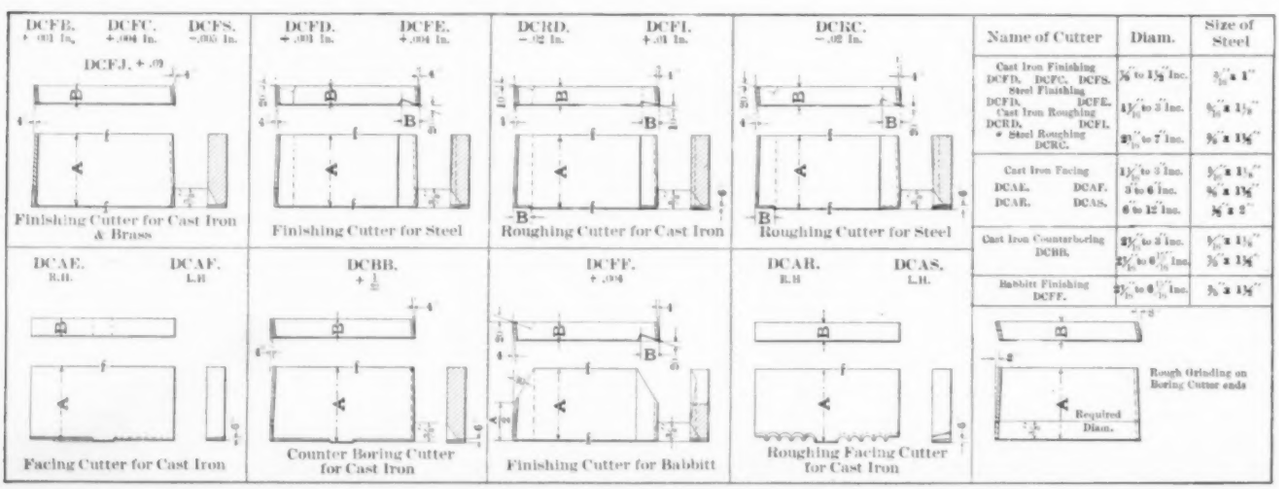
TOP FACE

8° Front Rake					18° Side Rake				
Left Hand					Right Hand				
Hor. Angle 97.6		Ver. Angle 108°			Hor. Angle 97.6		Ver. Angle 72°		
Set horizontal angle on mach. 60° and make C about ½ A.	Size of Cutter	A	Maximum Length	Minimum Length	Set horizontal angle on mach. 60° and make C about ½ A.	Size of Cutter	A	Maximum Length	Minimum Length
	¼	¼	1⅞	¾		¼	¼	1⅞	¾
	⅜	⅜	2⅛	1¼		⅜	⅜	2⅛	1¼
	5/16	5/16	3	1¾		5/16	5/16	3	1¾
	½	½	4⅛	2½		½	½	4⅛	2½

END FACE

Clearance 6°	Horizontal angle on mach. 96°					
Size of tool	¼	⅜	5/16	½		
Use former A and grind until the index finger points to	2	3	5	7		

FIG. 1. SINGLE-END BORING CUTTERS



Name of Cutter	Diam.	Size of Steel
Cast Iron Finishing DCFD. DCFC. DCFS. Steel Finishing	⅝ to 1½ Inc.	5/16 x 1
DCFD. DCFE. Cast Iron Roughing	1⅝ to 3 Inc.	5/16 x 1⅛
DCRD. DCFI. Steel Roughing DCRC.	2⅝ to 7 Inc.	5/16 x 1⅛
Cast Iron Facing	1⅝ to 3 Inc.	5/16 x 1⅛
DCAE. DCAF.	3 to 6 Inc.	⅜ x 1⅛
DCAR. DCAS.	6 to 12 Inc.	⅜ x 2
Cast Iron Counterboring DCBB.	2⅝ to 3 Inc.	5/16 x 1⅛
	2⅝ to 6 Inc.	⅜ x 1⅛
Babbitt Finishing DCFF.	2⅝ to 6 Inc.	⅜ x 1⅛

FIG. 2. DOUBLE-END CUTTERS

grinder for grinding the cutters to size. This attachment, shown at Fig. 3, consists of a V slide operated by hand and moving parallel to the face of the wheel. Mounted on the V slide is a cross slide forming the cutter holder, operated by a screw having a micrometer index, reading to thousandths of an inch. The cutter holder is provided with thumb nuts for clamping the work.

This holder has a slope of 4 degrees from the horizontal plane and at a right angle to the face of the wheel, the high end being next to the wheel. This 4-degree slope gives the cutter 4 degrees clearance. In grinding, the cutter is

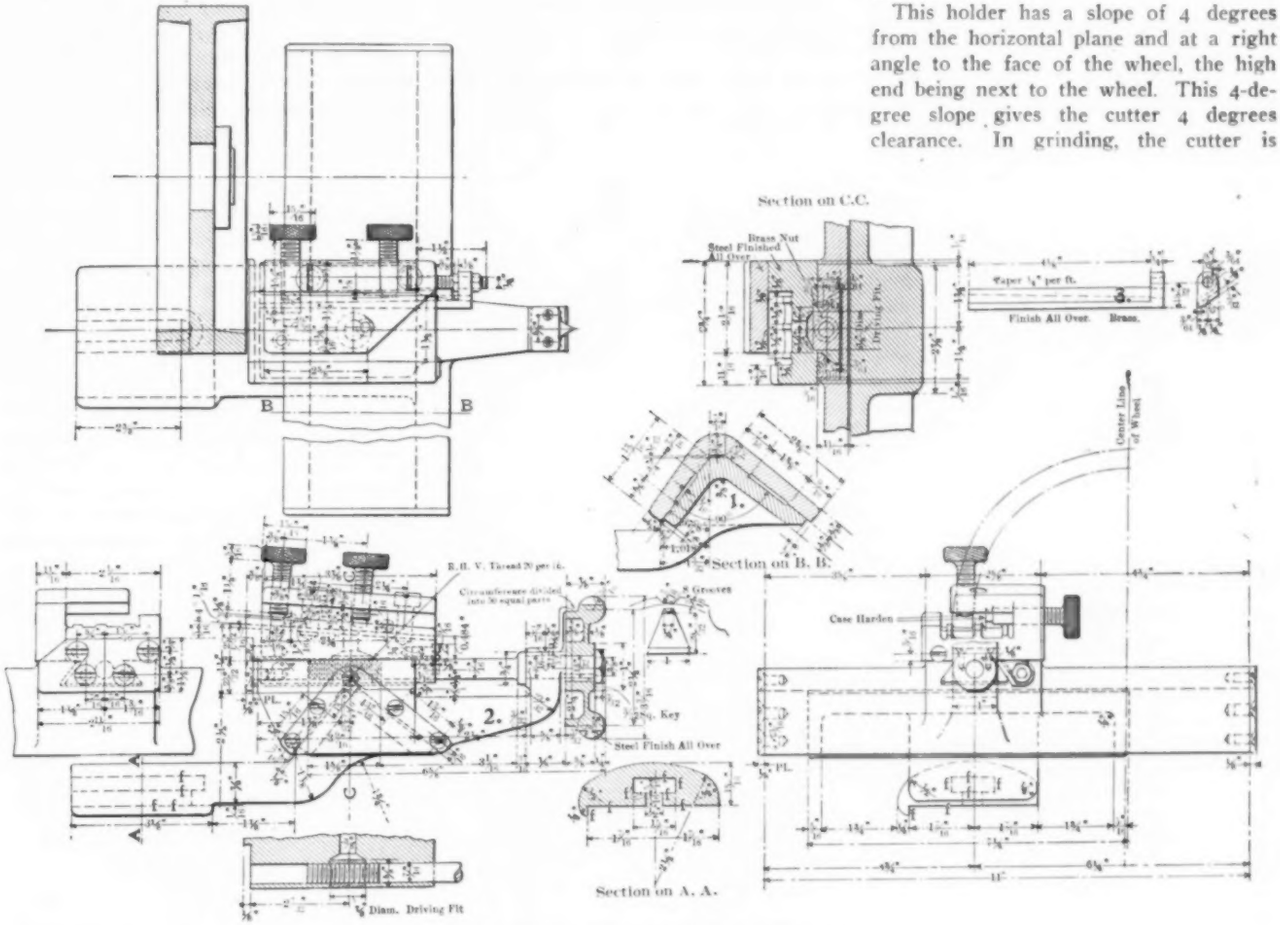


FIG. 3. ATTACHMENT FOR GRINDING CUTTERS

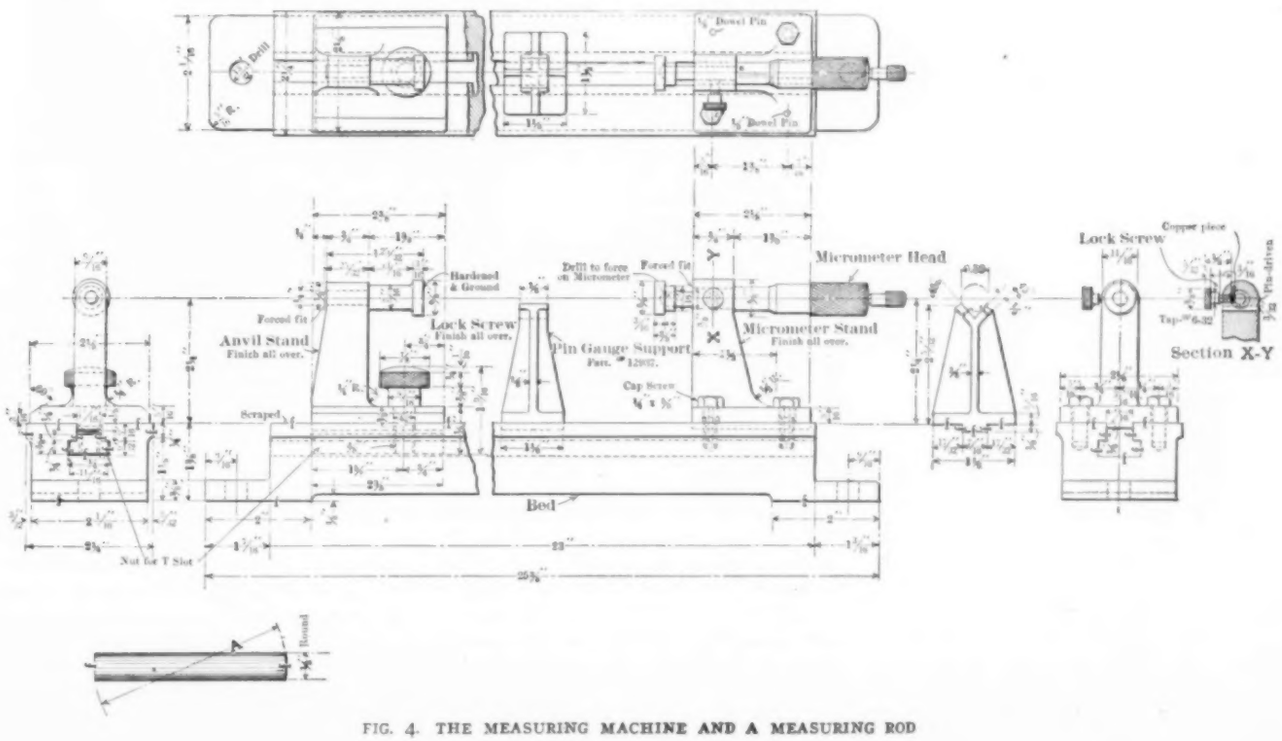


FIG. 4. THE MEASURING MACHINE AND A MEASURING ROD

clamped on its flat side in the cutter holder, with the intended cutting edge up and with the cutter seat against the side of the holder. The edge or land is ground off until it is about ⅜ inch long. The cutter is then turned end for end, keeping the cutter seat against the side of the holder and the second land ground off until it is nearly ⅜ inch long. Now the cutter is taken from the holder and measured, the amount still to be taken off noted and the cutter again placed in the cutter holder. The cutter is then ground down to the required diameter in the following way: After it has been clamped the holder is fed in until the cutter just touches the wheel, the micrometer index is used and the required amount ground off. The finished edge is stoned to remove any bur that might be left in grinding. To insure accuracy the cutter should be remeasured and tried for square, but it rarely happens that a cutter has to be ground after the final measuring. An emery wheel M grade and 80 grain is used for the finish grinding.

and a movable one with an anvil. The movable one has a binding screw, so that it can be set and clamped at any desired position on the bed.

A set of end measuring rods, from 1 to 6 inches long, varying by ¼ inch, is provided. These are made of ½-inch rod turned to the required diameter, thus giving line contact on their ends. By making them this way two or more rods may be used in setting the instrument. When measuring, the head is set by sliding it toward the fixed head, having the nearest end measuring rod between the contact points of the heads. The sliding head is clamped and the micrometer is then set to exact size.

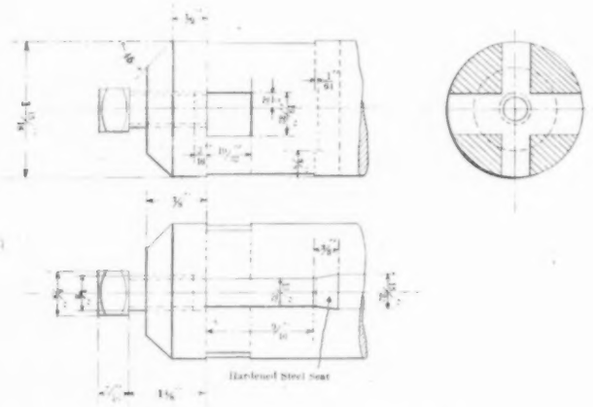


FIG. 5. STANDARD BORING-BAR ENDS

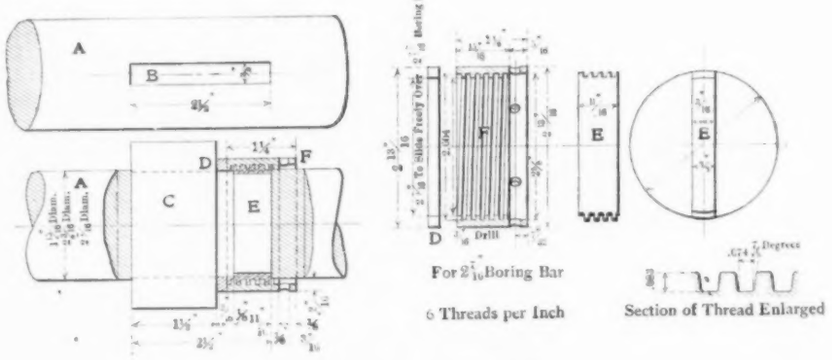


FIG. 7. THE LARGEST BARS

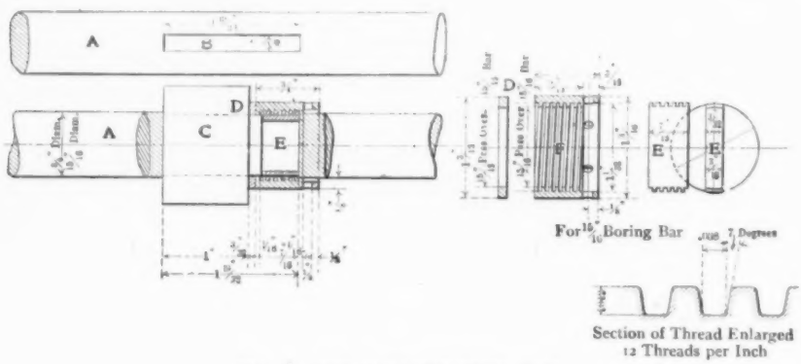


FIG. 6. THE SMALLEST-SIZED BARS

Measuring Machine

No standard measuring machine could be found on the market to measure the cutters satisfactorily, so it was decided to build one. This machine is shown in Fig. 4. It was designed and built in the shops.

The bed of the machine is of cast iron. Fitted to the bed are two heads, a stationary one with a standard micrometer head,

Standard Boring-bar Ends

To accommodate the square-stock single-end roughing cutters and the flat cutters, a new boring-bar end was designed. This is shown in Fig. 5.

The square slot for the roughing cutters is at right angles to the slot for the finishing cutters. The slot is off center so as to bring the cutting edge of a new tool beyond the center of the hole being bored by about one-third the hight of the nose of the tool. When the cutter is ground down one-third of its hight, it may be reversed in the slot, thus bringing the cutting edge to the same position, with relation to the center, as that of a new one. This permits practically the same cutting and clearance angles to be maintained throughout the life of the cutter, which should not be used after the nose is ground below one-third its hight.

All bars are made from cold-rolled steel with a hardened-steel seat inserted in the finishing slot. In boring bars supported at the far end, and where the cutters are near the middle of the bar, such as are used in horizontal boring machines, drill presses and lathes, the cutter is secured by a nut, as shown in Figs. 6 and 7.

The bar *A* is slotted at *B*. This slot is long enough to accommodate the cutter *C* and threaded member *E* and to allow 5/16 inch in the large sizes and 5/32 inch in the small sizes between *E* and *C*. The externally threaded member *E* is made in the shape of a threaded bar, the length depending on the number required. The material is tool steel and it may be tempered or not, as desired, after the threaded slabs are cut from the bar. The nuts *F* are made from soft steel case-hardened, as are also the washers *D*. The threaded member *E* centers itself in the nut and bar, and in case the threads are damaged, is easily replaced. There is no tendency to upset or bur the ends of the slot, as there is when a wedge is used. Fig. 6 shows the larger sizes from 1 15/16 to 2 7/16 inches, and Fig. 7 the smallest sizes, ¾ and 15/16 inch. The intermediate sizes can easily be worked out from these.

Boring Practice

All holes in cast iron 1⅛ inches and less are drilled from the solid. All work done in turret and boring lathes is roughed with double-end cutters. Holes above 3 7/16 inches should be roughed with a single-end cutter and at least three cuts should be taken through the holes. Collars, where a good finish is not required, can be finished in one cut. The cutter preceding the finishing cut should be a double-end roughing cutter leaving about 1/64 inch depth of cut for the finishing cutter. Large bores may be finished with a single-end square-nose cutter.

In steel all holes under 1 15/16 inches diameter should be drilled from the solid. Bored holes are rough bored with single-end cutters, but four-lipped drills are advantageous on holes below 2 15/16 inches diameter.

Finishing cutters should not be used to remove more than 1/64 inch of metal. Soda water may be used on all finishing in steel. Babbitt metal should be rough bored with single-end cutters, followed by a steel roughing cutter. The finishing is done by a babbitt finishing cutter.

A Transmission Dynamometer

By W. F. Durand

This dynamometer is of the same general style of design as that described in the recent New York meeting of the Society of Mechanical Engineers, differing only in size and in detail of construction. While the small dynamometer described in the paper referred to was intended for some 6 or 7 horse-power, the dynamometer here shown is intended for 40 to 50 horse-power.

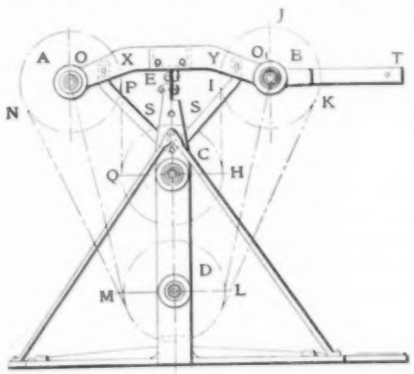


FIG. 1. DIAGRAM OF THE DYNAMOMETER

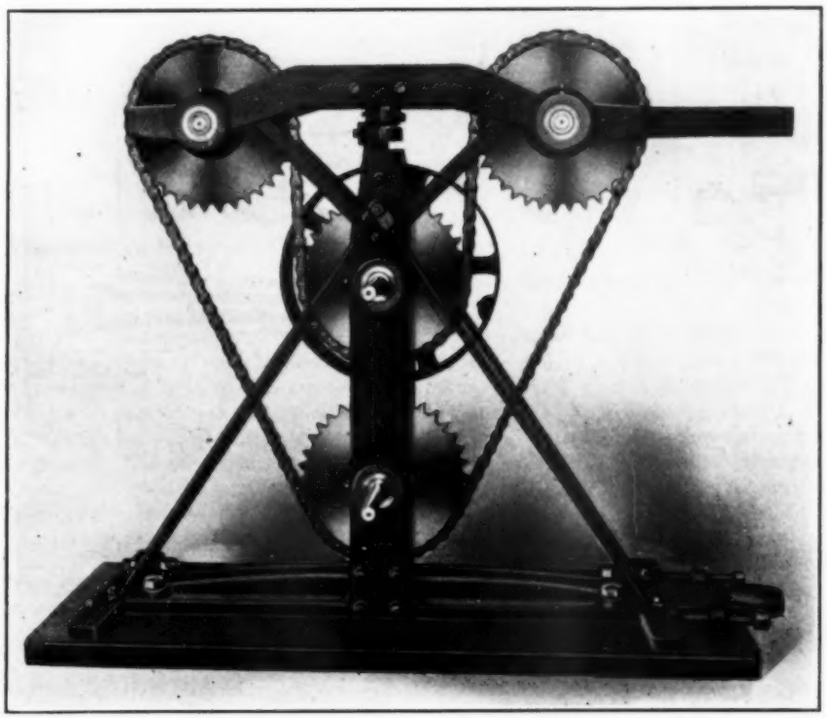


FIG. 2. THE DYNAMOMETER

In the construction as shown in Fig. 1, *A* and *B* are two sprocket wheels mounted on a frame *X Y*, which is carried by the well known Emery steel-plate support or knife edge at *E*. The frame sides *X Y* are double, carrying the sprockets between them, and are mounted on a hollow cast-iron box as a distance piece at the center. To this box the Emery support at *E* is attached. These details of construction will be more plainly seen from the general view of the apparatus in Fig. 2. In order to limit the motion of the frame *X Y*, bars *S S* are mounted as shown, with a notch the sides of which engage with a pin seated in the upright frame. The extent of the notch is enough larger than the pin to allow the desired freedom of movement, perhaps one-half inch on either side of a mean position at the end of the horizontal arm. While this arrangement permits perfect freedom of movement for the purpose of the measurement of the turning moment, it prevents at the same time movement to such an extent as to develop any sensible force within the steel-plate supports.

The lower sprockets *C* and *D* are similar in size to *A* and *B*, and are mounted as shown on the side standards, which in turn are attached to the base. The base proper is again mounted on a sub-base; it is provided with holding-down bolts working in slotted openings, and with forcing screws to provide a take-up for belt tension and for securing in place as desired. The sprocket shafts extend on either side, and on these extensions pulleys may be mounted, or universal joint couplings may be attached for the receipt and delivery of power. The chain is led as shown in the figures, and it will be plain that, if, for example, power be put in at the sprocket *C* and taken out at *D* with right-hand rotation, the two parts of the chain passing over *B* will represent the tight side, while the two which pass over *A* will similarly represent the loose side, and there will result a turning or rocking moment tending to depress the right-hand end of the rocking frame. This can be measured by a spring balance or beam scale, as may be convenient, and gives a direct measure of the torque or turning moment operating at the sprockets *D* and *C*. By appropriate calibration with a friction brake on the delivery pulley, the relation between the readings of the beam scale or spring balance and the brake readings is readily established, and hence the relation between scale or balance readings and delivered torque. Such torque being multiplied by the number of revolutions per minute gives, according to the usual rule, the power delivered in foot pounds per minute.

In order to reduce the friction to a minimum, ball or roller bearings are employed throughout; with the bearings and chain kept in proper condition it may reasonably be assumed that whatever the small amount of friction loss may be it will remain sensibly constant for a given load, and will thus admit of elimination by the calibration noted above.

The general dimensions of the dynamometer are as follows:

Diameter of sprockets..... 12 inches
Thickness of sprockets..... ½ inch
Type, automobile.

The imports of American locomotives into Brazil, in 1906, were more than threefold the value of the imports in 1905, and more than sixfold the value of those of 1904, but German manufacturers, who had been all but driven out of the market, have recently secured an order for 17 locomotives, in competition with American machines.

Chain, automobile, one-inch pitch, 5000 pounds strength.

Hight over all	42	inches
Length of base	48	inches
Width of base	16	inches

[In Vol. 29, Part 2, page 787, is a description of the smaller dynamometer referred to by Mr. Durand.—Ed.]

Some Shop Tools and Methods—Locating Centers and Turning Spherical Bearings

By F. J. Le Card

The following tools and methods for bench-lathe work have been thoroughly tested and proved highly satisfactory; I submit to the reader the question of their being mechanical.

Fig. 1 presents an article in mild or bessemer steel. Having quite a number to turn out, I went at the work systematically, with the following results.

The Important Points

The three essentials in getting out the pieces were a perfect partial globe, with large and small holes at right angles to each other and exactly central with the ball in the same plane.

To start with I turned the plug, Fig. 2, true and parallel by the micrometer, and held in a taper collet or chuck so as to be returned to the same position.

Next I made the hole *a* in the place shown in Figs. 3, 4 and 5. This operation is worthy of special notice, as it is of very general use. The plug or any similar round piece is clamped to a *true* and *straight* face plate, as shown at Fig. 3 and Fig. 4.

Clamps Without Blocks

I have dispensed long since with numberless blocks of metal or wood for clamping purposes, and get the same result with the adjusting and clamping screws *c* and *d* in conjunction with the clamp *e*, tapering at the end and open, so as to be placed without removing screw *d*.

I have a set of three in one size, with 3/16x32 screws of assorted lengths and a number of washers *f*.

Then I use the driving plate *h*, with numerous tapped holes for screws *d*, for all small work in preference to the usual heavy face plate with cross T-slots.

Locating the Center

Using the ordinary V drilling center for placing the piece *b* against the face plate, I test the same, as partly seen in Fig. 3, with a Starrett or other indicator.

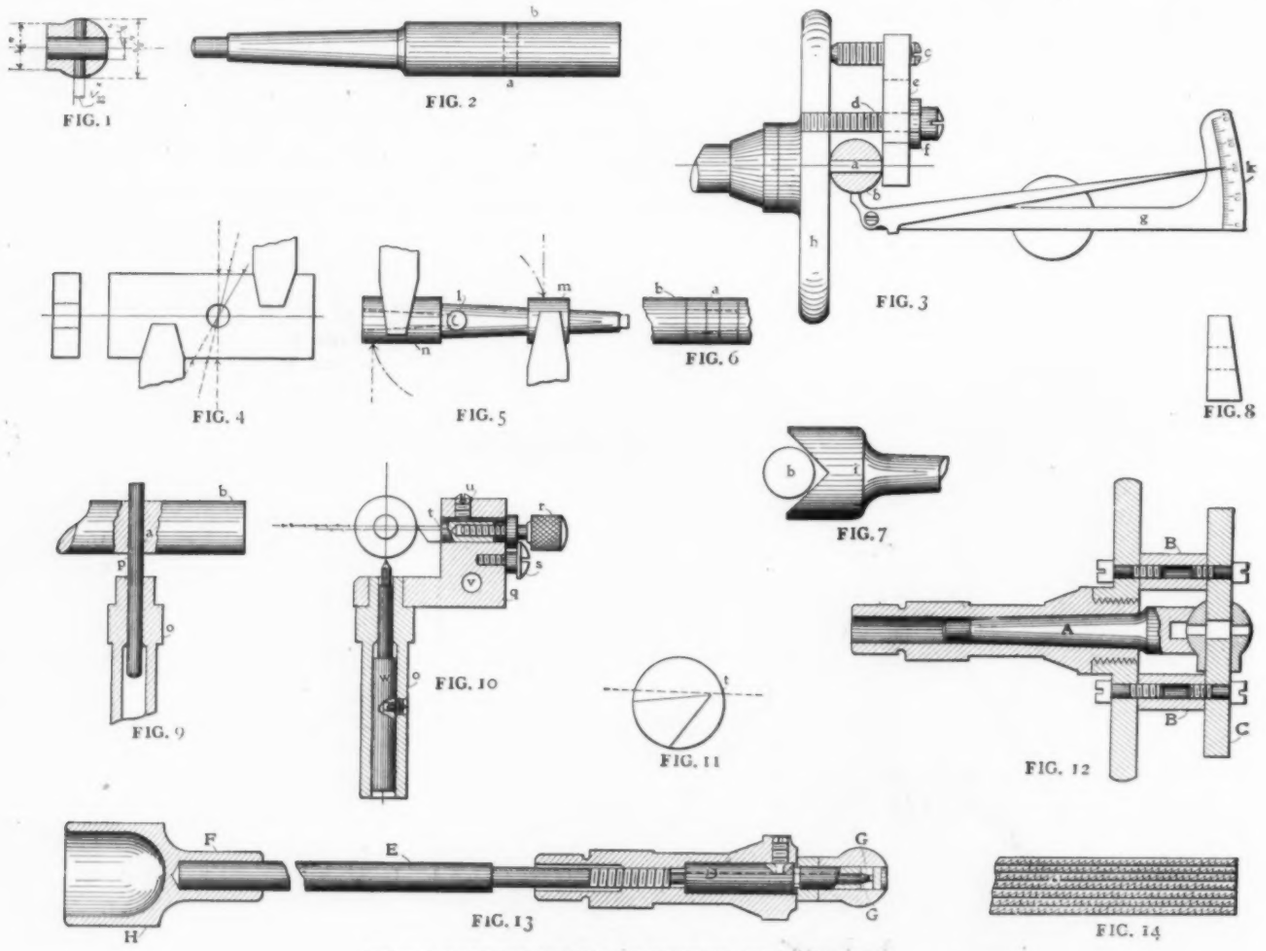
In regard to the use of the V center for placing *b* approximately, if everything was in perfect alinement on the lathe parts, and the V center accurate, there is no law to prevent the piece on the face plate from being right; but the indicator generally shows up a fault somewhere.

The testing method is said to be partly seen from the fact that two other important factors need to be explained, viz., the piece *b* to be tested must be turned exactly half a revolution. All the bench lathes of standard make have index holes in the flange of the pulley back of the large cone and an index pin. Usually there are 120 holes. So by using quarter marks, it is easy to get principal divisions without counting the holes. These are generally homemade.

Using the Indicator

The other factor is the importance of bringing the indicator in contact with the work in the same position each time, or on opposite sides of the work. This is done by holding the indicator rigidly in the slide rest, always at the same distance radially from the lathe center.

It will be seen from Fig. 4 by the *v* marks that the indicator contact need not



DETAILS SHOWING METHOD OF TURNING SPHERICAL PIECE

be exactly over the center so long as the work is exactly parallel; or whether it is round, square, oblong or irregular, like Fig. 8.

Then with the work of exact width or diameter at the contact points, turn the lathe one-half turn, and the contact at the same distance from the center for both sides; knock the work on the face plate until the indicator finger at *k* shows both sides of *b* alike, and things are O. K. for a dead center.

Drilling a Taper Shank

Should it be desired to make a drift-pin hole say in a collet, with taper shank, as seen at *l*, Fig. 5, make a brass collar or ring *m;* for rapidity, the same diameter as *n*. Clamp the work from opposite sides, to balance the lathe and admit of indicator contact as shown by dotted lines.

The collar *m* can be made very quickly, with hole to correct size for position on the shank, by catching a piece of round brass stock in a three-jawed chuck, turning outside diameter, boring taper hole 2 degrees, or whatever it may be, and cutting off collar, all at one holding.

Fig. 6 gives an idea of a cheap jig for drilling a number of holes like *l* in tapers of a uniform size. The hole *a* is obtained as explained; and the balance by the corresponding method of making *m*. See dotted lines.

Turning the Ball

Referring to Fig. 9 and Fig. 10, *o* is a post fitted closely to the common T or hand-tool rest of the bench lathe; the pin *p* is a snug fit to the *very* true hole in *o*, and the same in *b* at *a*, which locates the swivel center of the ball-turning tool Fig. 10, in the vertical center of the lathe, as seen in both Fig. 9 and Fig. 10.

Having previously drilled two dowel-pin holes, and a free hole for the body of a binding screw in the T-rest holder, I transferred the position of the latter hole to the slide-rest shoe with a scriber; drilled and tapped a hole in the latter for binding when in position.

Then re-locating as in Fig. 9, I tightened the shoe to the lathe bed and bound the T-rest holder to the shoe, loosened the shoe from the lathe, put dowel holes in the shoe, and so had the tool, Fig. 10, always ready to return to the vertical center of the lathe and movable to any position lineally on the lathe, on the shears of the latter.

The Tool Holder and Tool

The tool holder *q* is attached immovably to the post *o*, and is provided with a feed and a retaining screw *r* and *s*.

The cutter *t* was made of round tool steel flattened on top to slide under the screw *u*. A handle about 2½ inches long was inserted at *V*. The tool worked to perfection.

The dotted lines on Fig. 10 and Fig. 11 show the center of the tool *t* below the center of the lathe to get stock for the cutting part. The point of the latter must be exactly on the horizontal center of the lathe to turn a ball or portion of same. This is easily obtained by bluing *t* in the fire for marking purposes.

Then while in the blank form, have it in position on the lathe, and slide it over a sharp lathe center, with the dowel pins out of the holder to admit of it.

Keep the tool filed to the hight line, as seen at *t*, Fig. 10, and always sharpen on the front. Very slightly round the cutting point, with Arkansas oil stone, and give pitch on top for bessemer steel, as seen in Fig. 11, or flat for brass.

This tool cut so nicely that the foreman thought it needless to finish with oiled emery cloth, although it was for a ball bearing.

Spotting for Drilling

The center punch *w* was used for spotting the ball for drilling, using it with the work in the position turned and getting spots opposite with the lathe index, as before referred to.

The drilling of the holes, however, was not satisfactory, so I returned to the face plate as presented in Fig. 12 and made a true cup turning in the brass plug *A*. I secured two brass studs *B B* from the back of the face plate, and used a straight rod *C* as an arbor for the work, clamping it to the studs *B B*, after the latter were faced off in position to allow of drawing the arbor down about 1/1000 inch at each end. Then they were drilled, bored and reamed satisfactorily.

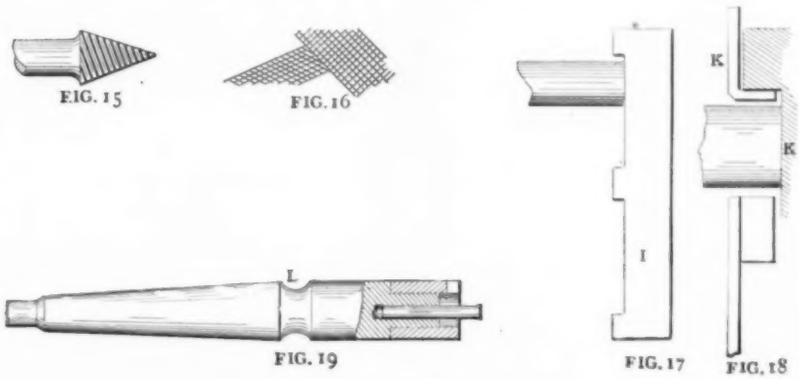


FIG. 15 FIG. 16 FIG. 17 FIG. 18 FIG. 19

WORK OF CHECKERING FILE AND MILLING-MACHINE KINK

Chuck Used for Turning

Fig. 13 is the chuck used for handling the work, and it acted instantaneously and positively endways. To turn truly, the fits must be *standard plug fits*, lapped to size and straight. The inserted piece *D* was hardened and locked with a screw, being turned at spring temper to remain true. Grinding would be preferable where possible. *E* is the expanding spindle or rod, a free fit at *F* in the drawn in spindle to prevent rattling. The expanding plugs *G G* are made of one piece sawed open after being countersunk 30 degrees over all, and turned off on the ends while in position. A slight pressure on nurled knob *H* will hold for a heavy cut.

The Checkering File

Fig. 14 is a kind of bird's-eye pre-Raphaelite view of what one of the old-line German workmen who was using one told me was a checkering file. It was the first one I had ever seen, and they certainly do fine work in the right kind of hands. I call to mind many samples of fine embellishment combined with utility which I have seen on gun stocks, dental forceps, etc., which I am told was done with these files. On page 253 I described a little snap-lock piece, apparently nurled but really filed in this way; and since then I have had some convex push-buttons checkered in the same manner.

Fig. 16 shows how different positions of the file work, and Fig. 15 pictures a two-threaded taper screw or worm that the man referred to was making to beat the band. He would start on one side and then opposite and split the threads, getting the pitch angle by heart. He said he could make a triple thread. I wondered if he couldn't make a twist drill by passing the 45-degree point.

Two Handy Kinks

I had some blocks, Fig. 17, to recut with an end mill. It was required to sink them deeper without touching the sides. Instead of coming up to the edge of the rigid block with a non-sensitive machine feed, which made it impossible to tell a touch from a dig, I used a thin bent slip *K*, Fig. 18, for a feeler (better than paper); when the cutter touches it, the slip flies. If the slip is 10/1000 thick and flat, feed up 9/1000 by the going index on the milling-machine handle and you're safe.

Tools similar to the one in Fig. 19 sometimes spring back of the hardened part in heating. They can be rectified by grooving at *L* on the soft stock and straightening by bending at this place.

A Large Hydraulic Forging Machine

By John Watt

In order to reduce the cost of certain smith-shop work done on the smaller fires at the Juniata shops of the Pennsylvania Railroad at Altoona, Penn., the multi-cylinder hydraulic forging and upsetting machine shown in Fig. 1 was designed and built.

The machine has been in operation over a year and has more than met the expectations of those responsible for its installation, as the average price paid for 32 operations now being done by it is only 21 per cent. of what these same operations cost when they were performed by hand, and the work is of course more uniform. This saving of 79 per cent. in cost of labor seems almost incredible.

The work for which dies have so far been prepared is the usual run of locomotive forgings. A few of these are shown at Fig. 2, and beneath each cut is the percentage of saving over hand methods. The dies are very simple and low priced, and the cuts of the work are shown more to call attention to the saving in cost than to show anything extraordinary about the shapes produced.

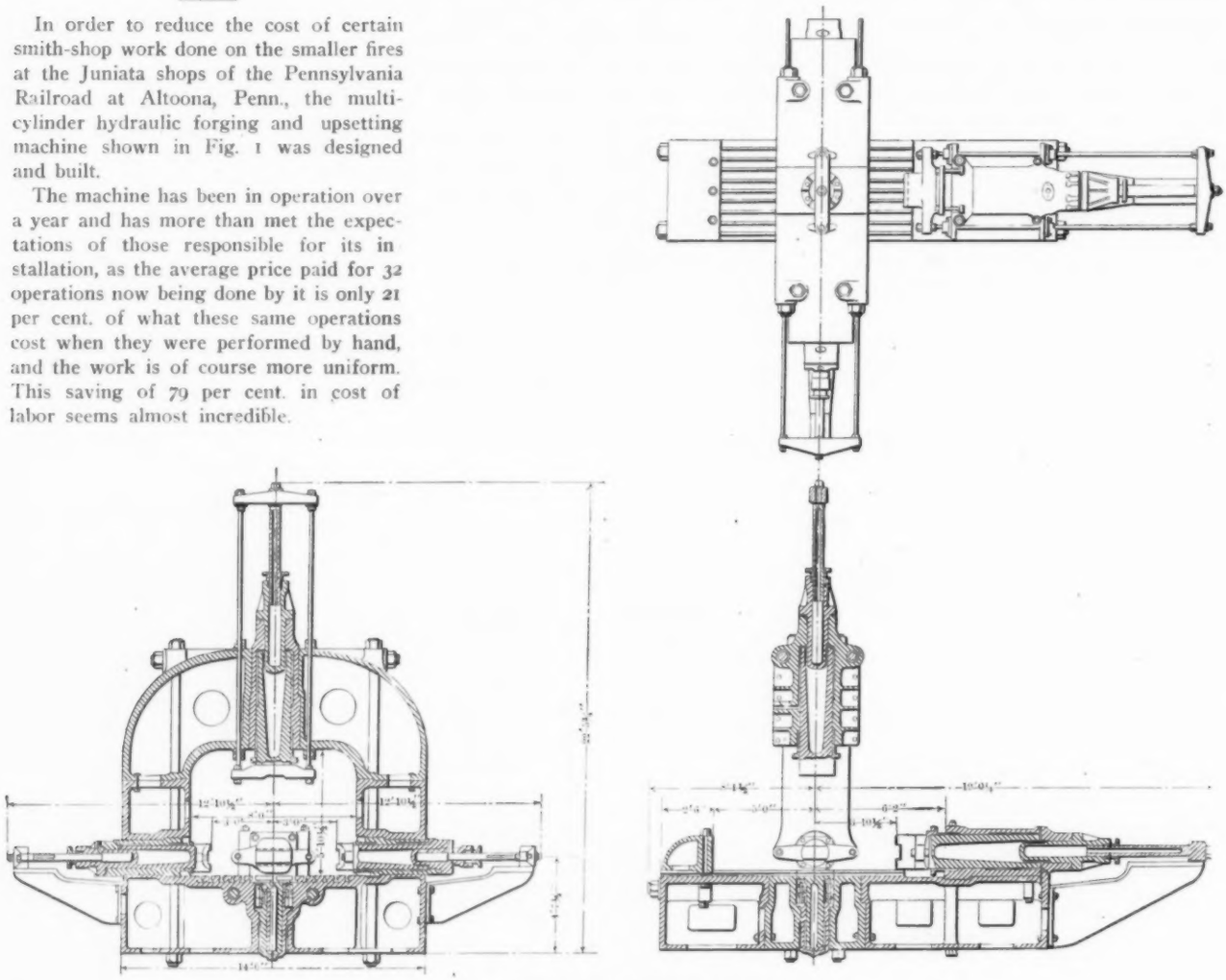


FIG. 1. HYDRAULIC FORGING MACHINE

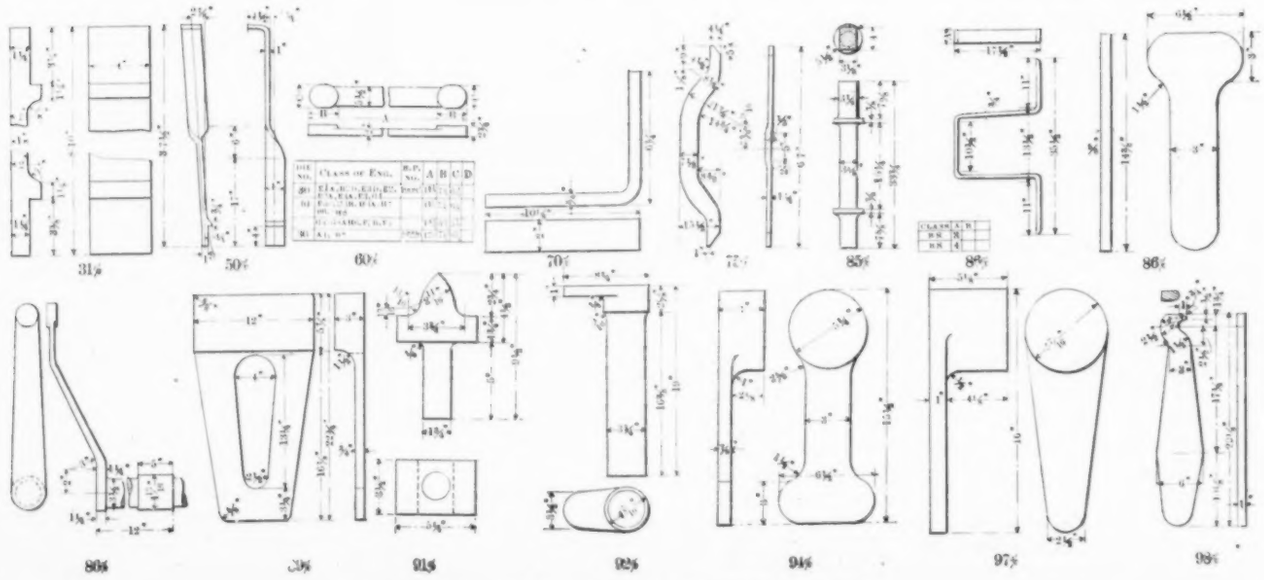


FIG. 2. SHOWING FORGINGS AND PERCENTAGE OF SAVING

The press consists of a bed plate and housings supporting five cylinders; two side rams, principally used for holding the dies and gripping the work when upsetting; a horizontal ram for upsetting and forming; a vertical ram for punching and shearing, also for forming parts that are more easily handled in a horizontal position. Underneath the bed, in a line with the vertical cylinder, is a stripping ram.

The capacity of the vertical and horizontal rams, each, is 200 tons; the two side rams 150 tons each, and the stripping ram 50 tons. All cylinders are steel castings.

The bed plate is in three sections, the housings in four. They are held together by steel rods, shrunk into place. The cylinders are all separate from the bed and housings, to allow for their easy removal.

The machine is controlled by one man, from a platform where a full view can be had of any operation. The water pressure used is 1500 pounds per square inch.

A special overhead traveling crane serves the press, taking the iron out of the furnace, placing it in position, and removing the finished pieces.

An invention has been patented by F. R. Hill, Frant-road, Thornton Heath, and Mr. Glass, by means of which the actual speed run by motor cars during the measured furlong upward to one mile is printed on a special chart, which need not be renewed for several months, and also prints the total mileage traversed. The chart, which has a definite and regular travel apart from the movement of the car, is graduated in the same way as a clock face, and assuming that the police have measured off 220 yards, and are timing the speed for this distance, on the approach of a car, say at 2:47 p.m., immediately the constable holds up his hand the driver presses a key, which prints a special sign indicating the exact time of the stoppage, and the chart will show in what time the 220 yards were run.—*Mechanical World.*

Using Worn-out Bolt Chasers

By Alvah B. Brown

I have charge of a small machine shop that uses a large number of bolt dies. The chasers are constantly wearing out and accumulate very fast. The toolroom boy asked me one day what he would do with a large box, containing about a bushel or more of these. This question, together with the size of the pile of steel, which is sometimes so hard to get, set me thinking.

The foreman I served my time under had a "nobby," and that was jigs and fixtures. I guess it must have been contagious and I caught it.

We have shafting of various sizes and lengths which have castings pinned on, so out of these old chasers I made plates to guide the drill. They work finely, as they are made out of a very good grade of steel, and when hardened wear for a long time.

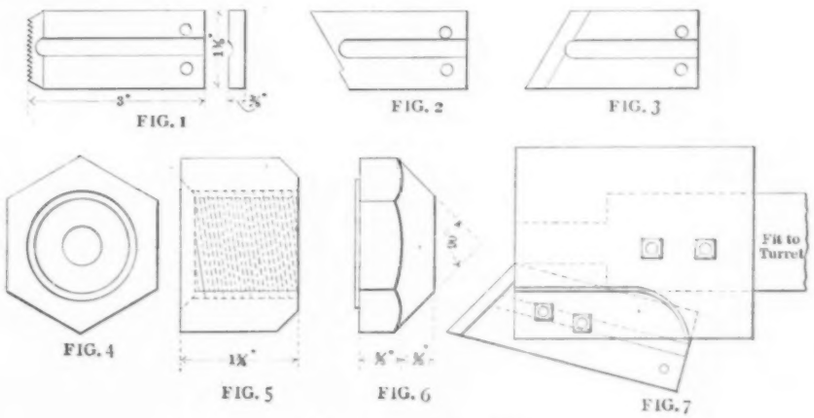


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7

USING WORN-OUT BOLT CHASERS

Other Uses

We have a large quantity of 1¾-inch hex nuts to face up every year. These nuts come rough and have to be bored and chamfered, tapped and faced to a special shape. There is enough stock on them to make almost two nuts finished to our standard, which is 45 degrees on one side, and on the other side square with clearance. The nuts were 1¾ inches thick and when finished were 1¼ inches thick in the center and ⅝ inch on the edge.

The job had always been done on a nut mandrel and "going right after them" with a facing tool. There was so much stock to remove, it took some time and was a job that had to be stood over, as it was nearly all hand-feed work.

Using an Old Pulley Lathe

In the shop we had a machine made for boring pulleys, but that did not do very satisfactory work. It had a turret on the carriage, and into one of the boring-bar holes we fitted a stud to carry a facing head made out of a piece of cold-drawn shafting and attached to the stud by set-screws. We milled a slot into the head and fitted a bolt-die chaser ground to have a cutting edge the shape of the finished nut, and fastened it in with two set-screws.

Next we made a mandrel to fit the hole in the spindle, with a thread to fit the nut and long enough to go through the nut and into a hole bored in the facing head. This acted as a pilot as well as a mandrel. After screwing the nut on this mandrel and setting two chuck jaws down on it to drive it, our machine was ready for business and a quick, smooth job was done in much less time than on an ordinary lathe. This job not only uses bolt-die chasers for cutters, but uses a machine that would otherwise be idle the greater part of the time.

Fig. 1 is one of the worn-out dies with an oval slot milled in the side; Figs. 2 and 3, the dies ground as facing cutters; Figs. 4 and 5, the rough hexagon nut; Fig. 6, the finished nut; Fig. 7, the facing head on the turret with the cutter set for facing the 45-degree side of the nut.

Determining the Composition of Industrial Gases

Professor F. Haber has devised a method for ascertaining approximately the composition of a gas by means of its index of refraction. This, he finds, can be obtained with great accuracy by observing the displacement of the image which occurs on looking with a telescope at a distant object through a glass prism into which the gas is led. He uses an instrument made by Zeiss, of Jena, consisting of a prism telescope, a glass prism for the gas or air, and a mirror. The observer looks, not at a distant object, but at a luminous spot situated in the telescope itself. On looking into the instrument one sees a dark shadow, which falls upon a scale in a position corresponding to the composition of the gas in the prism. The method is simple, and has the advantage that the refractive index as compared with air, of a sample of gas, remains the same, provided any changes of temperature and pressure affect equally the sample and the air under comparison. If chimney gases be led through the prism, an increase of 0.9 per cent. in the carbon dioxide causes the shadow to be displaced one division on the scale. The instrument is sensitive to 0.0000003 in the index of refraction, which corresponds to a change of 0.2 to 0.25 per cent. of carbon dioxide in chimney gases. Methane (marsh gas), hydrogen, hydrochloric acid, and hydrocyanic acid can be determined in air with the same delicacy. In the case of acetylene or sulphuretted hydrogen the exactitude is twice as great; for sulphur dioxide, 2½ times as great; and for the vapors of pentane and benzene, nearly ten times as great. Its sensitiveness has been proved quite satisfactory.—*Engineering.*

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Arithmetical Short-cuts

The following is offered as bearing upon a kink published in these columns and may be of interest:

I was much interested in the arithmetical short-cut given at page 284, by Professor Sweet, for finding the area of small squares which measure a fraction over the units figure, as 7½, 4½, 4¼, 7⅞, but it struck me as leaving one point altogether untouched, i.e., the rule for determining the value of the final added fraction in each case.

The rule holds good in squaring sizes involving fractions of any denomination, as for instance:

$$2\tfrac{6}{7} \times 2\tfrac{6}{7} = 3 \times 2\tfrac{5}{7} + \tfrac{1}{49} = 8\tfrac{8}{49}.$$

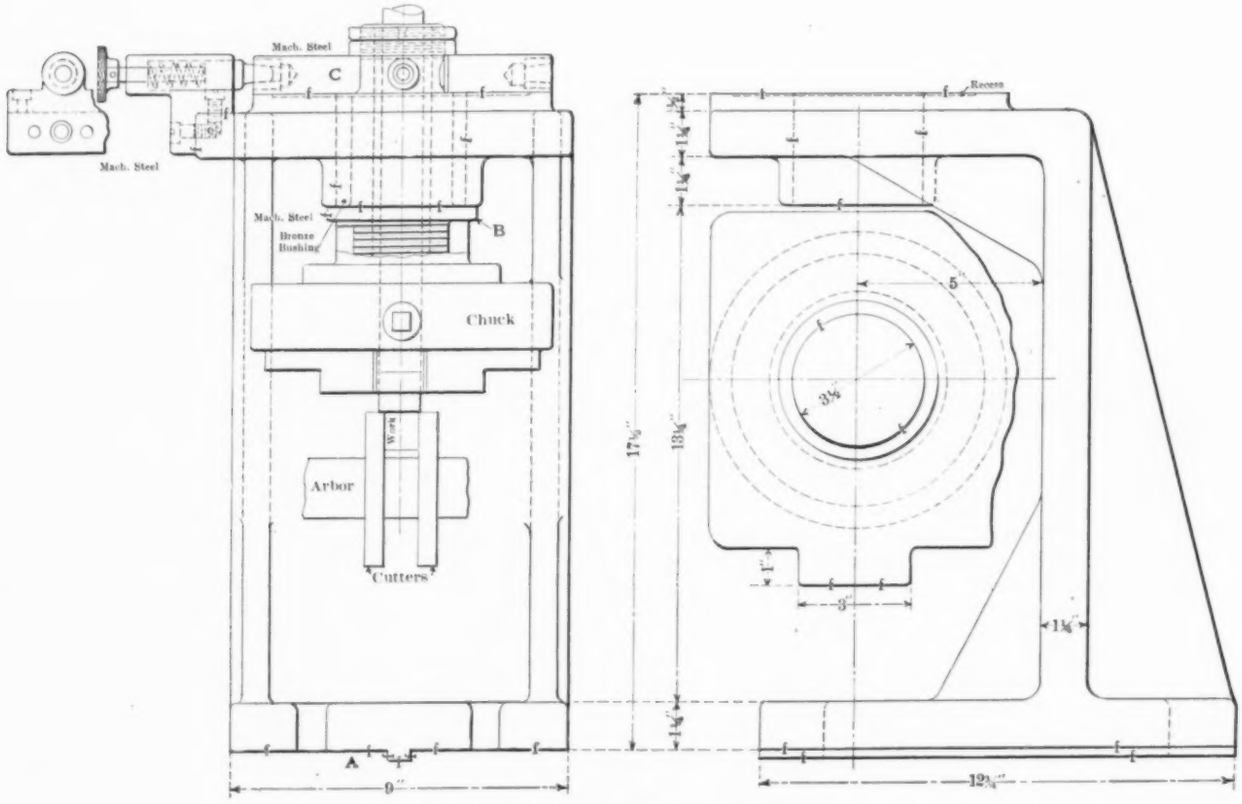
WM. B. MILLGATE.

Gainsborough, Eng.

A Rig for Milling Square Ends on Shafts

A milling rig for squaring ends of shafts, saving the bother of raising the milling-machine table up and down, as in the usual way, is shown in the accompanying sketch. The cast-iron knee is bolted to the table at *A*; the hollow spindle *B*, to which the chuck is screwed, permits shafts of reasonable length to be squared. The index plate *C* is keyed to the spindle and contains four hardened taper bushings for the spring pin to fall in. This rig has proved a time-saver for this work, and further description, I feel, is unnecessary, as the sketch shows the rig complete and speaks for itself.

GERALD.



A RIG FOR MILLING SQUARE ENDS ON SHAFTS

The examples given call for the addition of ¼, ¼, 1/16, 1/64, respectively. Now the ¼ is added in the first two cases because the area required is the result of squaring a measure ending with ½ and is the product of $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$. The 1/16 in the third case is the outcome of $\frac{1}{4} \times \frac{1}{4}$, and the 1/64 in the last example is required as being $\frac{1}{8} \times \frac{1}{8}$. The rule stated simply is: Square the denominator of the given fraction and the product becomes the denominator of the required fraction, whose numerator must be 1.

Screw Threads Most in Use

In the article by Mr. Moore, at page 691, he remarks, "The V thread, which is the most used"—and calls the 13 thread to the inch on ½-inch screws "foreign." These statements are rather surprising, though they may be true.

It is now something over 40 years since the Franklin Institute adopted the report of the committee, of which William Sellers was chairman, on screw threads—which was called for a time the Franklin Institute Standard.

The two main features differing from former practice were the flat top and bottom to the thread, and 13 threads for the ½-inch size. It also recommended certain sizes for heads and nuts, which had been more or less haphazard before. These sizes and styles of threads were adopted by the United States authorities not long after; later by the Railway, Locomotive and Car Building Associations, by many large corporations, and hundreds of private concerns. So it seems strange that the V thread is still "most

used," and the cause may be worth looking into.

Along in the early days the Morse Twist Drill Company added to its business of making twist drills that of making standard taps, and printed as a foot-note to its circulars, "That, unless otherwise ordered, V threads would be furnished." At one of the early meetings of the American Society of Mechanical Engineers, Mr. Stetson, then superintendent of the works, said that 80 per cent. of all their orders were for V threads.

Some years later, when the railroad companies adopted the U. S. Standard, the Pratt & Whitney company, undertook to establish the standard and furnish test gages for U. S. Standard, V and Whitworth threads.

In speaking with Mr. Bond, while he still had charge of that work at the works of Pratt & Whitney, he told me that 80 per cent. of their orders were for U. S. Standard. This shows fairly conclusively that if the Morse Twist Drill Company, and its followers, mostly New England concerns, had furnished U. S. Standard, rather than V, unless otherwise ordered, we should now have 80 per cent. or more using that standard.

I understand perfectly that if these concerns should now at this late date change their practice they would soon be in hot water, as all of their old customers would expect them to duplicate their old style even if furnished 20 or more years before without saying anything about style.

The only thing they could do to change the foot-note would be to say: "In ordering taps and dies *state whether you want U. S. Standard or V threads.*"

In this case those who were starting in new would be starting in right if furnished U. S. Standard, where nothing was said, or if no order were filled until the customer's preference was learned.

JOHN E. SWEET.

Improved Planer Tool Holder

The sketch shows a tool I have used for some time on planer work, and for many uses it is ahead of any tool I have ever used. One of its great advantages is in any kind of undercutting.

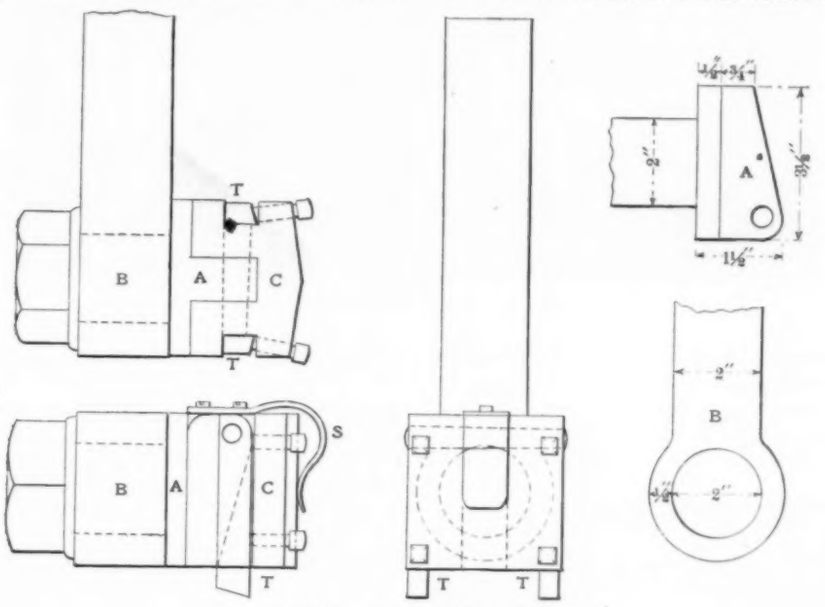
It consists of a square shank with an eye on the end, as shown at *B*, and of any desired length. The apron *A* fits this, and turns in it to secure any desired angle. The end of *A* has a tongue which guides and carries a clapper box *C*. This acts as the tool post or holder, and is planed out to carry a ½x¾-inch tool on each side if desired.

These tools *T T* are beveled on top, and the set-screws put in at an angle, so as to hold them solidly in place, and not let the tools work loose even under the heaviest cuts.

The entire tool holder can be turned to any desired angle and one or two tools can be used in almost any way desired. Among its good points is the ability to get down close to the work when occasion requires. Turned sideways it can be used right or left, as desired.

The bar *B* is of machine steel, but the apron *A* should be of tool steel.

H. J. B.



IMPROVED PLANER TOOL HOLDER

Another Pump Repair

In reading over the graphical description of a young repairman by George, at page 766, there recurs to my mind an incident that happened years ago when I was working in a repair shop. The telephone rang. A voice at the other end said: "Sind a man to repair my pump; the thing has the ricketts, by jabers."

On arriving at the place I found a small Blake pump which was required to force water 1000 feet up a hill, also to lift 8 feet from a tank. I first inquired about the suction line, and was told there was but one joint in the line. After turning on the steam I concluded the trouble was in the water end, and upon examination it was found in fairly good shape. After making this better the pump acted the same and Mr. Hooligan began to worry and sweat. Next I had them uncover the line at the joint mentioned, but found it perfectly tight. Finally, I took the pick myself and, starting at the tank, followed the line back for 15 feet, when I came across a double ell with a check in it, which Mr. H. had forgotten "entoirely." This check was turned over on its side and was leaking at the cap.

Upon turning the check upright and repairing it, the pump went to work and Mr. Hooligan was happy again. Patting me on the shoulder, he said: "By jabers, bye, you do know your business after all."

A. GREASER.

Fiber Bearings for Grinding Fixtures

Under the head of "Internal Grinding," on page 320, I read about the trouble which Sparks had with internal grinding. As I am foreman toolmaker in a factory which has a considerable lot of internal grinding to do, I can understand these troubles. I have been up against them myself. We generally make our spindles for internal-grinding fixtures of ⅜-inch Crescent steel by just turning one end down about ½ inch long by ¼ inch diameter, and cutting thread to hold a nut and small wheel.

The spindles would get all cut up and run out of true in a very short time; then they would make a lot of noise. The bearings, which were made of brass, would wear out very fast.

It occurred to me that the material which I call red fiber would make a good bearing, so I tried it for the regular Brown & Sharpe internal-grinding fixture which has been in the shop for about eight years. We have had a lot of work done with the new bearings, and they have given good satisfaction. When we took out the spindle and examined it, instead of being cut up, the surface was glazed and in good condition; the man running the grinder has very little trouble now, and he is greatly pleased with the new bearings. This may not be new to some but I feel sure it is not generally known.

MICHAEL MCGIVEN.

Annealing High-speed Steel

I've had a good, hearty laugh at the way C. N. Scott jumps on me about annealing steel, and I also see that he fell into the little "bucket of water" that was purposely put at the end of my article.

If Mr. Scott will take the trouble to look at the article again, he'll see that no

reference whatever is made to the use of water-hardened novo as a *tool*. A man who would think of using air-hardening steel hardened in that way very evidently wouldn't know his business. But when mere hardness is concerned, a piece hardened in the way I mentioned is *hard* but not *tough*, and will not hold an edge for any length of time. As he says that he is through using water-hardened Novo, he has probably experimented in that direction.

As to the time taken to heat a piece for annealing as I directed on page 534, it is a mistake on the face of it, as the directions I give say to "heat *slowly*, turning occasionally to *get heat even*, and when at a *nice white* (not burning) *heat*, bury it in the lime," etc. If read carefully it would not have misled anyone.

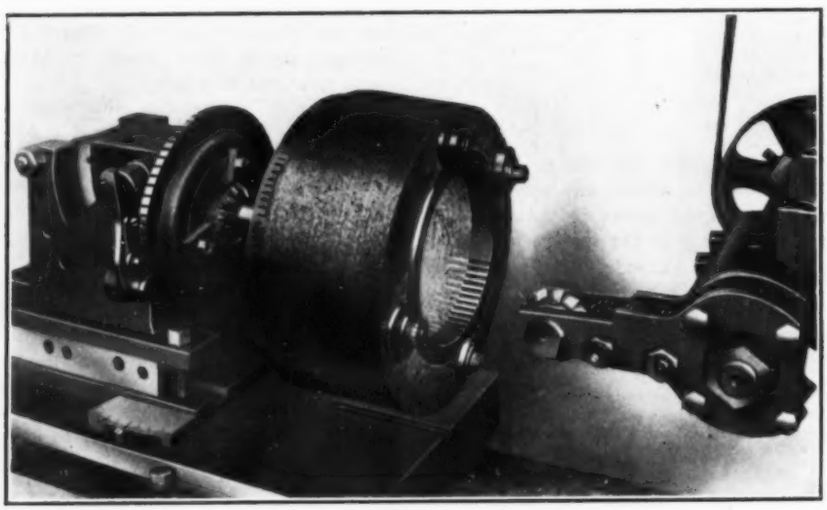
As to trying every piece to see if it is soft, it isn't necessary; because, when one has done a few lots my way, he knows he can rely on the result.

It seems to be Brother Scott's chief failing to leave a good deal to the imagination, or he takes it for granted the reader knows what he means. He didn't tell how he cools his steel after he reheats his lead to get it out. It looks to me as if he was putting his steel back into nearly the same place as at the start.

ETHAN VIALL.

Internal Gear-cutting Attachment

Going through the shops of the Philadelphia Gear Works recently, I was attracted by the attachment shown in the



AN INTERNAL GEAR-CUTTING ATTACHMENT

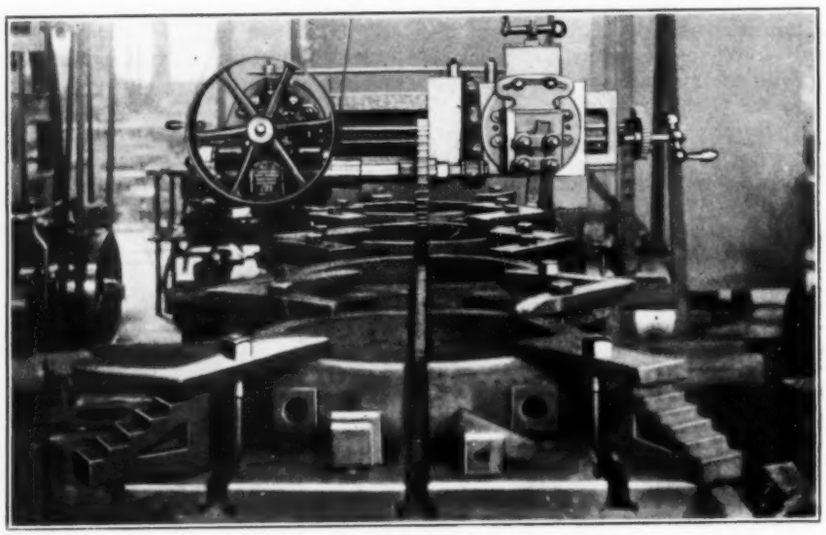
illustration. It was attached to a hand machine and was doing satisfactory work. The gear blanks were held by four wood screws and washers in the wooden chuck turned out to receive them. The drive is by a train of spur gears, as shown.

A larger device used on one of the large machines in the same works is driven by a double train of gears, one on either side of the cutter.

DIXIE.

The Farwell Milling Attachment in Railway Work

The illustration shows an old planer, which, after thirty years of continued service, has been converted into a milling machine by the use of a Farwell milling attachment. This is at work milling the joints of two rows of locomotive eccentric straps.



FARWELL MILLING ATTACHMENT AT WORK

The time taken to mill in this way is less than one-half that taken when the machine was running as a planer.

We find the machine very useful for a large variety of work, and believe other railway shops can convert some of their planers to advantage.

M. H. WESTBROOK.

One Reason for Buying a Long-bed Lathe

The remarks of L. A. M., on page 570, on "bushing" pulleys and the college professor, and his milling machine recall to my mind a somewhat similar incident which took place here not long ago, though not in an engineering works, and which had to do with the installation of a new lathe in the repair department.

The manager of the plant is one who believes in the necessity of personal supervision on his part of everything and everybody, from the office boy up, so the buying of such an important piece of machinery as a lathe was not to be delegated to any subordinate. As a good portion of the manager's experience had not been unconnected with the butcher business in earlier years, there was much speculation by the boys in the shop as to what sort of a "brute" the "old man" would bring back on the day he started out gunning for a lathe. It might be added that a 16-inch lathe of very short bed would have answered all requirements as the work was solely of the face-plate and chuck variety.

The "old man" duly returned with the announcement that he had purchased a 30-inch lathe with a 16-foot bed. When questioned as to the purpose of the unnecessary length, he said it would come in handy when they wanted to turn up shafting and such things. Bill, the all-round mechanical genius who, with the aid of a hammer and chisel, managed to keep things running in his department, was ordered to get the new lathe in place and running as soon as it arrived. Bill carried out his orders up to a certain point, and then went to the "old man" with a list of the shafting and pulleys necessary to get power to the new acquisition. The "old man" looked at the

list and then at Bill, and wanted to know "Why in —— they should buy shafting after he had purposely bought that lathe long enough so they could make their own." It took no little effort on Bill's part to keep a straight face while he explained the situation, and it was some time before the "old man" convinced himself that he had bought the wrong kind of lathe after all. MERRIMAC.

H——, England.

Press Tools for Bail Ears

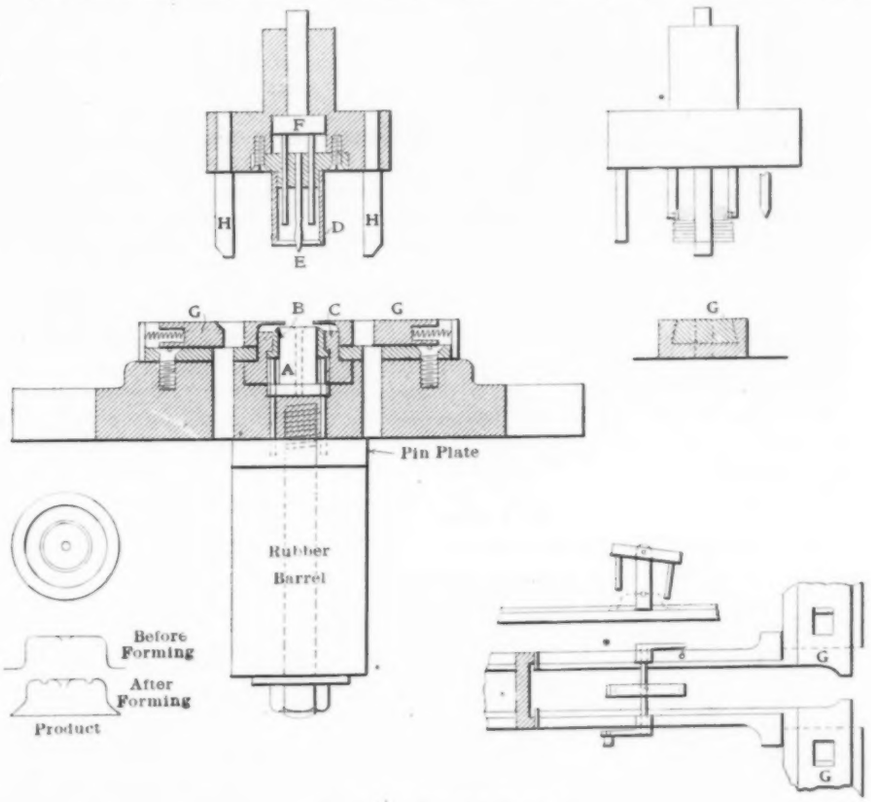
The press tools shown in the accompanying cuts were designed to form and trim bail ears, for tin pails, buckets, etc. The ear is soldered to the side of the pail, and a wire handle or bail is inserted in the center hole, which is drawn instead of punched, to give more wearing surface. The tools were designed for rapid production, and their success can be judged from the fact that the presses run continuously at 120 revolutions per minute, an ear being formed and trimmed for each stroke. This is about as fast as a live boy can feed.

Accuracy and uniformity of product throughout the life of the tools are easily secured, and low cost of maintenance is cared for, as will be noticed by an inspection of the forms of the cutting edge, forming ring, pick-up pin and especially the punch. These parts only need replacing from wear. As for life, the punch is upset lightly once a week, the cutting edge ground once a month, and the punch properly refitted. The cutting edge and punch last about a year if run continuously.

In the illustration the center post *A* is used merely to guide the forming and stripping ring *B*, which is supported through the pins and pin plate by the rubber barrel which supplies the necessary forming pressure. The cutting edge *c* is driven into its seat, given very little clearance at the edge, about ¼ per cent., and left quite hard, that is, drawn just below the chipping point.

The cutting punch *D*, which, it will be noticed, is a very small part of the whole, is also hardened, but drawn to a light blue, at which temper it can be worked in the lathe and upset with safety. The punch is held by a pressing fit to the plug, facilitating construction and repair and furnishing a convenient means of holding the pick-up pin *E*, which enters the hole in the ear. This in turn is stripped by the knock-out *F* operated by a cross bar in the gate. The press is inclined as usual. The punch enters the die only a few thousandths of an inch, sufficient to separate the ear from the trimmed scrap, which remains on the punch so that it cannot get into the die or in the way. As this scrap accumulates, it is cut by the cutters shown in the side view, and is slid sideways out of the way. If the front cutter is made one thickness of stock longer, the scrap is slid backward also.

In rapid production the manner of feeding is important; the hopper feed here shown is reliable and easily adapted to a variety of forms. The hopper is designed to hold a number of pieces which are arrested in their downward motion by the lower arm of the double bell crank that is supported by a shaft and two standards, operated by a small lever on one side, and brought back to position by a spring acting on a lever on the other side, as shown. The bell crank is operated through the lever by a finger fastened to the press ram; as one arm descends, the other rises; thus the short arm holds the pieces in the hopper while the longer arm permits only one to escape. This slides down into the hopper plates or wings *G*, which slide in their channels when operated by the pushers *H*, and are returned to their position by springs, the cutting edge acting as a stop. SIRIUS.



PRESS TOOLS FOR BAIL EARS

Forming-tool Holders

In the accompanying drawing are shown two kinds of forming-tool holders which cannot slip or change position after being once set. One is for heavy, while the other is for light work. The cutters can be taken out, ground and replaced in the holders in exactly the same position.

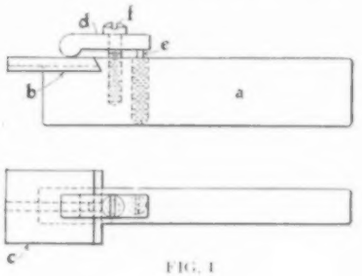


FIG. 1

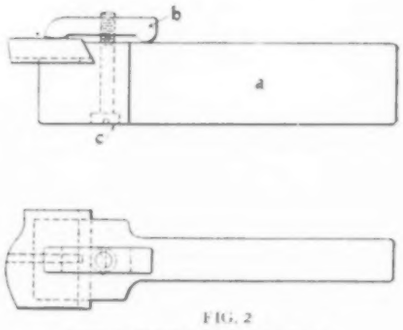


FIG. 2

TWO FORMING-TOOL HOLDERS

In Fig. 1 is shown a light forming-tool holder *a*. On the end is a rib *b*, ⅛ inch wide and 1/16 inch high; the former *c* rests against a wall at an angle of 60 degrees. The strap *d* is rounded on the bottom and rests on a stop-pin screw *e*; a machine screw *f* clamps it securely.

Fig. 2 shows a heavy forming-tool holder, which consists of a tool-steel body *a* planed all over, hardened and drawn to a spring temper. A rib is also planed on the front end with a wall of 60 degrees for the former to back against. The strap *b*, with a machine screw, holds it firmly in position. R. A ALMOND.

The Drawing of Screw Threads

On page 495 is published an unsigned article which I judge was intended to shake down a few ideas on the general subject of the representation of screw threads on drawings. I cannot agree with the conclusions, but I heartily agree that some uniformity in drafting-room practice would be a great help. The method of showing a thread in Fig. 1, page 495, is what I have called a lazy man's method, because it was first brought to my attention by a man whose most prominent quality was laziness. It is all right in nine cases out of ten, provided it is the understood practice of the shop where it is used. The drawing in question would have had a correct interpretation if the body of the screw had been dimensioned. This would appear to be a superfluous dimension as long as the diameter of the tap was given,

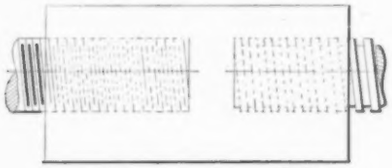
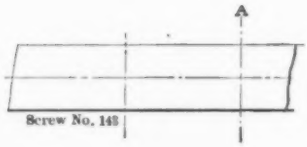


FIG. 1 FIG. 2



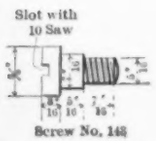


FIG. 3

METHODS OF DRAWING SCREW THREADS

but it would have been more apt to receive proper attention if the 3/8-inch dimension had been placed across the body of the screw and only the pitch of the thread had been specified at the right.

With regard to Fig. 2, page 495, I should say that the shop was justified in making this thread any way they pleased, so far as anything on the drawing showed. It is neither a square thread nor a V-thread.

Fig. 3 in the article referred to is unmistakable, but look at the work it makes in the drawing. Most men have no serious objection to work, but most of us, if there is any way out of it, hate to putter around putting in a lot of little marks which have to be placed just so carefully to look well.

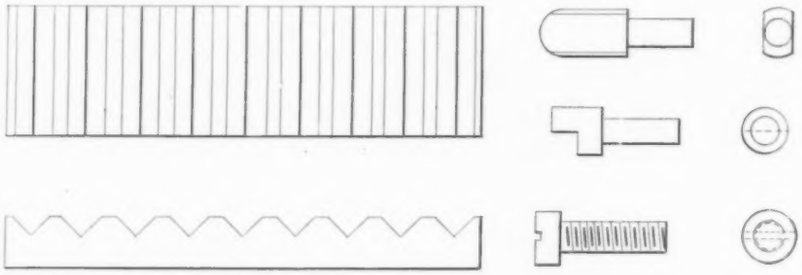
I am probably getting to be old-fashioned, but I cannot see why the old, old ways of representing V and square threads need to be improved upon, that is, if you need to represent them at all. My Figs. 1 and 2 show what I mean. They are not difficult to make and they are recognized by practically everyone.

If it is too much work to do even this, try my method, the one which I use when I am in a hurry, as shown in Fig. 3. Just put in a center line and put against it what you want, as at *a*; or, if you want a special screw, put in your center line and letter it. Off in some corner of the sheet draw the screw that you want. Then, better still, put all these drawings of special screws on a set of small sheets by themselves. By and by you will find that you can work in some of these special screws on other machines that you are building and save increasing your line of screw-machine work.

CON WISE.

Milling and Slotting Fixture for the Milling Machine

As I had a number of various kinds and sizes of studs on which to mill the sides flat, also the slotting of different sizes of screws, and found the index head



FIXTURE FOR MILLING AND SLOTTING SCREWS AND STUDS

slow work, I designed and made a fixture for milling, as shown.

Using this device the operator did the work in one-quarter the time it took to do it on the index head. Among the good features of this fixture are the rigidity of the work, which is held in the milling-machine vise, and the high rate of speed and feed, doing away with moving the table feed back for each piece, as with the index head, causing considerable delay.

A piece of machinery steel is finished all over, the length and hight of the vise jaws, and V-slots cut 1 inch apart, or any distance suited for the work. The depth of all slots is the same.

The fixture is used with the 90-degree grooves facing the movable jaw of the vise, the top of the fixture acting as a stop, to let the head of the screw or stud stop at the shoulder, so as to mill and slot all pieces to the same depth.

If there is a slight variation in the diameters where the clamping occurs, a piece of cardboard placed between the screws or studs and movable vise will hold the work. Where I have to mill a screw or stud of larger diameter than the distance from the center of one slot to the center of the next, I put the screws or studs in every other groove.

FRANK G. STERLING.

Checking the Compression Space of a Hydrocarbon Engine

On page 736 E. J. Bartlett describes a method of finding the actual volume of the compression space in an engine, which depends for its accuracy on the comparative weight of a wooden pattern and a cubic inch of the same kind of wood. I wonder why it did not occur to him to plunge his irregular-shaped pattern into a pail of water and measure the amount displaced, thereby doing away with all possibility of error, provided the pattern is of accurate dimensions?

E. R. PLAISTED.

A Pump Experience in the West

I have been very much interested in the letters which have appeared in your columns under the head of "Echoes from the Oil Country," as some of your correspondent's experiences have been so similar to my own.

I had a pump job on my hands about a year ago, which may be of interest to your readers, and undoubtedly some of them can tell me what was the matter with it. It was a direct single-acting steam pump with a 30-inch steam cylinder. It was located 700 feet below the surface in a mine. The owners of the mine claimed that it would not run at the speed called for in the contract nor deliver the specified quantity of water.

I made an examination and found the pump in good order, but piped in what I considered a very peculiar manner. On the discharge pipe, as close to the pump as possible, was an eight-inch swing check valve, then a horizontal rim of eight-inch pipe about 40 feet long, then an elbow and a 700-foot riser of eight-inch pipe extending vertically to the surface. To get the specified number of strokes from the pump was easy; all that was necessary was to open the throttle. But to muster up courage enough to stay in the mine with the pump at that speed was not so

easy, for the noise was simply terrific and the discharge pipe was all over the place.

I expressed the opinion that the swing check was the cause of all the trouble, as it made the air chamber practically useless. However, the pump was taken out and a pump of another make put in.

Will some of your readers kindly suggest to me what was wrong with the pump that I examined?

SENEX OCCIDENTALIS.

Nurled-head Clamping Screws

On page 743 I note that Draftsman, in an article entitled "A Milling Fixture," makes the assertion that nurled nuts are not satisfactory for clamping purposes in practice, owing to the fact that they wear the fingers. While I agree thoroughly with him in the practice of using some kind of a pin through the head of the clamping screw, where a good pressure is desired, there are a number of instances that I can call to mind where a nurled-head clamping screw was used to reduce the possibility of the user of the jig springing the work. We have even gone so far at times as to reduce the diameter or the thickness of the head of the screw where it was desired to make the jig especially *fool-proof*. The clamping screw with a pin through the head is very excellent in its place, but on light interchangeable work there are many cases where the nurled-headed screws are better for the reasons stated. CRITIC.

An Unusual Job of Drop Forging

The forging in question is that of an automobile axle, which from its length and shape makes it an unusually difficult piece to forge; so much so that automobile manufacturers have preferred to use bronze castings or welded axles, rather than attempt the task of forging the axle out of a solid bar. Special interest is also attached to this job as there have been many attempts to forge these axles, experiments having been conducted by some of the leading steel manufacturers of the country, which have resulted in costly failures. The job is all the more remarkable in that the axles are being made in a small shop, with the tools available.

In the half-tone, to the left is shown the completed axle, drilled and fitted ready to be assembled. In the center is shown a finished forging, before it receives the final bending. The axle leaves the forge shop in this condition owing to the fact that for different automobiles, different bends are required, the axles being otherwise identical. Fig. 2 gives the general dimensions of the forging.

The forging is made of "Clipper" steel, and is of stock 2½ inches square and cut to length, each piece weighing about 44 pounds. The heating is done in a coke fire, great care being exercised to secure a uniform heat.

The breaking-down dies are shown in

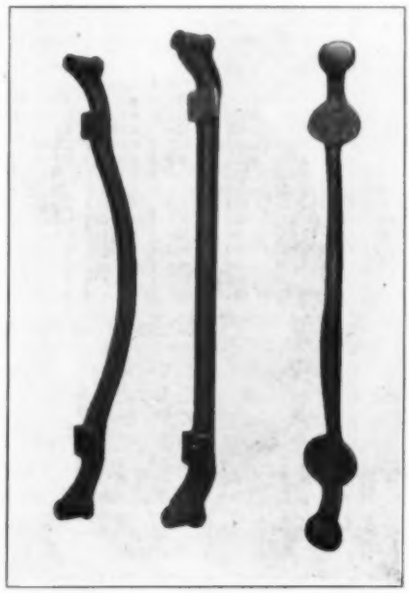


FIG. 1. THE AXLE IN THREE STAGES

Fig. 3 and present no unusual features. The stock is struck into the die at the *right* until the two balls have appeared, when it is struck in the dies at the *left*, to form the pad at *X*, Fig. 2. These dies are cast iron, used just as they came from the sand, without even being touched with a file.

The breaking down is done under a

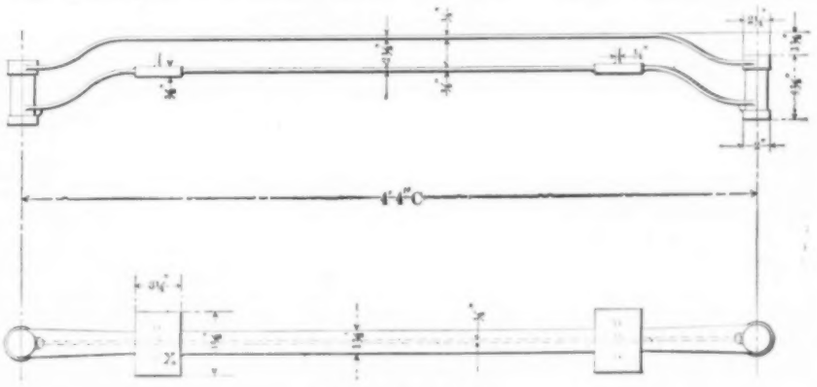
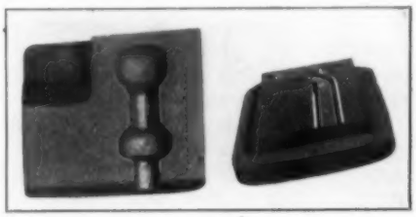


FIG. 2. THE AXLE

4000-pound steam hammer of the usual type. As a part of this breaking down, the forging is taken to a 1000-pound drop hammer near by and at the same heat the middle part of the axle, just inside the pad, is broken down and roughed to size. There are no gages or stops of any kind on the breaking-down dies for locating the pad, this being done entirely by the judgment of the operator.

The broken-down axle is shown at the right in Fig. 1, the breaking-down operation being of course the same for each end. The bend at the ends is done by a helper and sledge, as the axle lies on the anvil of the drop hammer after the breaking down is complete. This operation is also left to the judgment of the operator, and while it is a crude way to describe, is really very quickly done and also very accurately done.

The finishing dies, Fig. 4, are of steel, and present nothing unusual. The iron band shown shrunk in place is to hold in place an addition to the die that was



FIGS. 3 AND 4. THE BREAKING DOWN AND FINISHING DIES

found desirable, as it proved more satisfactory to make these dies take in as much of the axles as possible. In this operation the pad is inserted in the lower die and if necessary the sledge is used to bring the extreme end over the die in its proper place. Great care must be used when heating the stock during this operation, the heating requiring more time than the work of forging.

The first stroke of the hammer, when the forging is in the finishing dies, is a light one and is more for the purpose of settling the forging into place. After both ends have been finished the axle is drawn to size in the center, the distance between the ends being gaged. It is possible to maintain a limit of error of 3/16 inch in the forging, as shown in the center in Fig. 1. The bending at the factory is done in a screw press with cast-iron dies, stops being provided to catch the pads at the ends.

Throughout this job the personal equation enters in very largely, without which it would be impossible to do the job at all. The operator is a colored man who works with one helper.

The dies have been excellently designed, there being but about 8 pounds of scrap left during the operations, the finished forging weighing about 36 pounds. The flow of the metal is almost perfect, and the axles are knocked out very rapidly. The entire operation is a most happy combination of drop forging, drawing and hand work.

These axles were the only forged axles shown at the recent automobile show in Chicago and attracted considerable attention.

The axles are being forged by the Bates Forge Company, of Indianapolis, and the dies were prepared under the personal supervision of Franklyn P. Bates, president of the company.

R. P. KING.

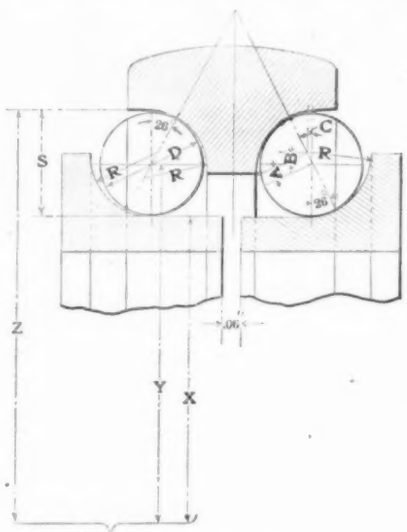
Two-point Ball-bearing Data

On page 458 of the AMERICAN MACHINIST is a table of data for four-point ball bearings.

The accompanying tables are worked out on a similar basis for two-point ball-bearings. They are from the same source, the Garford Company.

Dia. of Balls.	*R*	*A*	*B*	*C*	*S*	*S*–*D*
.250	.175	.050	.045	.022	.260	.010
.3125	.205	.049	.044	.021	.322	.010
.375	.240	.054	.047	.023	.386	.011
.4375	.275	.056	.051	.025	.449	.011
.500	.315	.055	.058	.029	.513	.013
.5625	.354	.073	.065	.032	.577	.015
.625	.394	.082	.073	.036	.641	.016
.6875	.433	.089	.080	.039	.705	.018
.750	.473	.098	.088	.043	.770	.020

ARTHUR B. HOWK.



TWO-POINT BALL-BEARING DATA

Dia. of Balls.	.25"			.3125"			.375"			.4375"			.50"			*D*
No. of Balls.	*X*	*Y*	*Z*	*X*	*Y*	*Z*	*X*	*Y*	*Z*	*X*	*Y*	*Z*	*X*	*Y*	*Z*	*N*
8	0.401	0.661	0.921	0.502	0.824	1.147	0.602	0.988	1.373	0.702	1.151	1.599	0.801	1.314	1.828	8
9	0.480	0.740	1.000	0.601	0.923	1.246	0.720	1.106	1.492	0.840	1.289	1.738	0.959	1.472	1.985	9
10	0.559	0.819	1.080	0.699	1.022	1.344	0.839	1.224	1.610	0.978	1.427	1.875	1.116	1.629	2.142	10
11	0.638	0.898	1.159	0.798	1.121	1.443	0.957	1.342	1.728	1.115	1.564	2.013	1.273	1.786	2.300	11
12	0.717	0.978	1.238	0.897	1.219	1.541	1.075	1.461	1.846	1.253	1.702	2.151	1.430	1.943	2.457	12
13	0.797	1.057	1.318	0.996	1.319	1.641	1.194	1.580	1.965	1.392	1.841	2.290	1.589	2.102	2.615	13
14	0.877	1.137	1.398	1.096	1.418	1.741	1.314	1.699	2.085	1.531	1.980	2.249	1.748	2.261	2.774	14
15	0.957	1.217	1.477	1.195	1.518	1.840	1.433	1.818	2.204	1.671	2.119	2.568	1.906	2.420	2.933	15
16	1.037	1.297	1.557	1.295	1.617	1.940	1.552	1.938	2.323	1.809	2.258	2.707	2.065	2.578	3.092	16
17	1.117	1.377	1.637	1.395	1.717	2.040	1.672	2.057	2.443	1.949	2.397	2.846	2.224	2.738	3.251	17
18	1.197	1.457	1.717	1.495	1.817	2.139	1.791	2.177	2.563	2.088	2.537	2.986	2.384	2.897	3.410	18
19	1.277	1.537	1.797	1.595	1.917	2.239	1.911	2.297	2.682	2.228	2.676	3.125	2.543	2.056	3.569	19
20	1.357	1.617	1.878	1.694	2.017	2.339	2.031	2.416	2.802	2.367	2.816	3.265	2.702	3.215	3.729	20
21	1.437	1.698	1.958	1.795	2.117	2.439	2.151	2.536	2.922	2.507	2.956	3.404	2.862	3.375	3.888	21
22	1.518	1.778	2.038	1.895	2.217	2.539	2.271	2.656	3.042	2.647	3.095	3.544	3.021	3.535	4.048	22
23	1.598	1.858	2.118	1.995	2.317	2.640	2.390	2.776	3.162	2.786	3.235	3.684	3.181	3.694	4.207	23
24	1.678	1.938	2.199	2.095	2.417	2.740	2.510	2.896	3.282	2.926	3.375	3.824	3.340	3.854	4.367	24
25	1.759	2.019	2.279	2.195	2.517	2.840	2.631	3.016	3.402	3.066	3.515	3.964	3.500	4.014	4.527	25
26	1.839	2.099	2.359	2.295	2.618	2.940	2.751	3.136	3.522	3.206	3.655	4.104	3.660	4.173	4.687	26
27	1.919	2.180	2.440	2.396	2.718	3.040	2.871	3.256	3.642	3.346	3.795	4.244	3.820	4.333	4.847	27
28	2.000	2.260	2.520	2.496	2.818	3.141	2.991	3.377	3.762	3.486	3.935	4.384	3.980	4.493	5.006	28
29	2.080	2.340	2.600	2.596	2.918	3.241	3.111	3.496	3.882	3.626	4.075	4.523	4.139	4.653	5.166	29
30	2.160	2.420	2.681	2.696	3.018	3.341	3.231	3.616	4.002	3.765	4.214	4.663	4.299	4.812	5.325	30

D = Diameter of Ball.
R = Radius of Race.
$A = R - \frac{D}{2}$
$B = A \cos. 26°$
$C = A \sin. 26°$

$S = 2(R - B)$.
$S - D$ = Clearance of Ball.
N = Number of Balls.

$$Y = \frac{D - 0.083"}{\sin. \frac{180°}{N}}$$

DIMENSIONS FOR TWO-POINT BEARINGS.

Dia. of Balls.	0.5625"			0.625"			0.6875"			0.750"			*D*
No. of Balls.	*X*	*Y*	*Z*	*X*	*Y*	*Z*	*X*	*Y*	*Z*	*X*	*Y*	*Z*	*N*
8	0.901	1.478	2.055	1.000	1.641	2.282	1.099	1.804	2.510	1.198	1.968	2.738	8
9	1.078	1.655	2.232	1.196	1.839	2.479	1.315	2.026	2.726	1.433	2.203	2.973	9
10	1.255	1.832	2.409	1.392	2.034	2.675	1.531	2.236	2.942	1.669	2.439	3.208	10
11	1.432	2.009	2.586	1.589	2.230	2.872	1.747	2.452	3.158	1.904	2.674	3.444	11
12	1.608	2.185	2.762	1.785	2.426	3.068	1.963	2.668	3.373	2.140	2.909	3.679	12
13	1.786	2.363	2.940	1.983	2.625	3.266	2.180	2.886	3.591	2.377	3.147	3.917	13
14	1.964	2.541	3.118	2.181	2.823	3.464	2.398	3.104	3.809	2.615	3.385	4.154	14
15	2.142	2.719	3.296	2.380	3.021	3.662	2.616	3.322	4.027	2.852	3.622	4.392	15
16	2.322	2.899	3.476	2.578	3.219	3.860	2.834	3.539	4.245	3.090	3.860	4.630	16
17	2.501	3.078	3.655	2.777	3.418	4.059	3.053	3.758	4.464	3.328	4.098	4.868	17
18	2.680	3.257	3.834	2.975	3.617	4.258	3.271	3.977	4.682	3.567	4.337	5.107	18
19	2.859	3.436	4.013	3.174	3.816	4.457	3.490	4.196	4.901	4.805	4.575	5.345	19
20	3.038	3.615	4.192	3.373	4.015	4.656	3.709	4.414	5.119	4.044	4.814	5.583	20
21	3.217	3.794	4.371	3.572	4.214	4.855	3.928	4.633	5.338	4.285	5.055	5.825	21
22	3.396	3.973	4.550	3.772	4.413	5.054	4.147	4.852	5.557	4.522	5.291	6.061	22
23	3.575	4.152	4.729	3.971	4.612	5.254	4.366	5.071	5.776	4.760	5.530	6.300	23
24	3.756	4.333	4.910	4.170	4.811	5.453	4.585	5.290	5.996	4.999	5.769	6.539	24
25	3.936	4.513	5.090	4.370	5.011	5.652	4.804	5.510	6.215	5.238	6.008	6.778	25
26	4.116	4.693	5.270	4.569	5.211	5.852	5.014	5.729	6.435	5.478	6.248	7.017	26
27	4.296	4.873	5.450	4.769	5.410	6.052	5.243	5.949	6.654	5.717	6.487	7.257	27
28	4.474	5.051	5.628	4.968	5.610	6.251	5.463	6.168	6.873	5.956	6.726	7.496	28
29	4.653	5.230	5.807	5.167	5.809	6.450	5.682	6.387	7.092	6.195	6.965	7.735	29
30	4.831	5.408	5.985	5.367	6.008	6.649	5.901	6.606	7.311	6.434	7.204	7.974	30

DIMENSIONS FOR TWO-POINT BEARINGS.

The Apprenticeship Question—The Cadillac System

Having read with interest your committee's report of the apprenticeship situation in the machinist trade, on page 745, I would like to inform you that the Cadillac Motor Car Company of Detroit, Mich., has now in vogue an apprenticeship system which is new in many respects.

It was brought into existence from two causes:

First—It was impossible to get men for this line of work who had sufficient skill to do high-grade work, particularly at the time of year when all the automobile manufacturers were busy. Many men and boys worked in the various assembling rooms and drill-press departments for a number of weeks and then moved to another factory, stating that they were drill-press hands, etc., when as a matter of fact, what little they have learned is learned so poorly that we would rather take a boy from the farm without any experience whatever.

Second—A great many young men who have had experience in other lines of work and who have a great desire to "get into the automobile business," many of whom are well educated and naturally bright, did not find any opportunity to get the primary training necessary to make them competent automobile men, either for repairing, driving or selling. It seemed too bad for such men to be put on a drill press, a milling machine, or assembly work, without any clearly defined system of training in all departments, so that they might come out efficient workmen. Hence this company organized the system outlined at the end of this.

Our mechanical instructor is a practical machinist and toolmaker who has also spent from three to four years in the drafting room and is in all respects a first-class mechanic. He visits *each apprentice every day* and is responsible for

their training; also advises them about what mechanical works to read, night schools, etc. We expect our department foremen to be so busy getting out work that their time for giving the apprentices the finer ideas about mechanical things will be very limited; hence it leaves a wide field for the instructor. The instructor works in harmony with each foreman in regard to speeds of tools, etc.

We are trying to make the course (two years) as complete as possible, supplementing the shortness of time by thorough instruction as the apprentice progresses with his practical work. I think we can teach a boy as much by this method in two years as was learned by the old method of "picking it up" in from three to four years.

We have mechanical lectures every four weeks with particular reference to gasolene engines and automobile work.

In fact our course (while we think it will qualify the apprentice for machinist's work as much as is possible in the length of time) is designed more particularly to fit young men for automobile work, in the manufacture, repairing and operation of automobiles. C. M. CARSON.

CADILLAC APPRENTICESHIP

All requests for information about the course may be made by mail, but it will be necessary for each applicant to call at our plant personally to make final, definite arrangements.

Each applicant must secure and deliver to us, for reference and filing, at least two written statements as to his character and probable fitness for the course, from reliable men who know him. We would advise applicants who do not live in Detroit to bring their references with them when they call on us, as this will save an additional trip home.

The course consists of two years of 300 days or 3000 hours each. The apprenticeship is divided into periods: First period, four months, drill-press work; second period, four months, milling-machine work; third period, six months, lathe work; fourth period, four months, bench work and engine assembling; fifth period, four months, bench work and chassis assembling; sixth period, two months, testing and driving.

Shop conditions may make it necessary to change the order of this outline, but it will give you an idea of the work taken up. Wages of apprentices are as follows: First six months, 10 cents an hour; second six months, 11 cents an hour; third six months, 12 cents an hour; fourth six months, 14 cents an hour.

It is the intention to give each apprentice who finishes the course in a satisfactory manner, a cash sum of $100 in addition to the wages quoted above. All statements made in this letter, however, are merely for the purpose of conveying information. They are subject to change at any time at the option of this company, and must not be construed as a proposition or agreement in any form.

Each accepted applicant is required to work for a trial period of four weeks at 10 cents an hour. If then he is deemed satisfactory, an agreement in duplicate is executed between himself and this company. This agreement covers fully the question of wages, term of service, the course of work, cash sum to be paid, and all other subjects connected with the apprenticeship. There is a competent instructor in charge of the apprentices, whose duty it is to guide the apprentices toward doing the work assigned to them in the best possible manner. Another valuable feature will be talks from time to time on automobile subjects by well posted men.

The standard of construction in the Cadillac factory is very high. For that reason, we want only conscientious, honest workmen, and believe that a young man of good character and habits, who will apply himself strictly to business and work hard, cannot help but be a success with this company.

I was particularly interested in the apprenticeship system and wage rates in your report of the Machine Tool Builders' convention. There is naturally a great difference of opinion as to enticing apprentices to learn a full course, so to speak, in which they can learn every detail, becoming all-around men to fill any position. The special apprenticeship system of the Bullard Machine Tool Works is commendable and is a step to bring the rising generation to a higher plane.

My experience with young men has been that not everyone is capable to take in a full course, that a great many of them are contented with covering only part of the conditions required and though they may become very efficient in one branch, their ambition does not include learning to be a full-fledged and thorough mechanic.

The saddest feature of our present young men is the grasp for money. They have not the ambition to learn to be proficient mechanics, but it is the money they desire most. Young men so inclined will make poor headway at whatever they may learn and are generally a failure. Various sports, running whole seasons, take the young apprentices' interest away from their duties and are a great drawback. Worse yet, they see the elder brethren just as crazy and lost in the desert that diverts their responsibility to something that brings them no return. It is unfortunately true that conditions now and 30 years ago are vastly different in the sticking qualities. Then you could depend on an apprentice to fulfil his engagements to the letter. I also believe that our present gigantic manufacturing interests have fewer chances for apprentices to learn a full course of what a truly good mechanic should be.

With our modern machinery for turning out work in great quantity and some of the machinery that almost talks, that works as a human being, where one operative needs very little experience to run from one to six machines, I would ask, where is the chance to learn a good trade? The good serviceable men come from small shops, with ingenuity and worth, but they are becoming infinitely few at the present time.

The allurements to entice the young and old from the path of rectitude are far greater now than years ago. When rest and quiet are required after working hours to give a clear mind and attention to his work for the next day's task, it is not possible that honest service can be given in keeping late hours.

There are vast differences between apprentices; some will learn rapidly, where others are very slow to take hold and would never make proficient mechanics. I have tried many ways to encourage them, but with poor results. The wage rates proposed by the Bullard shops I think are capital and ought to attract any apprentice.

I never restricted my apprentices or gave them a raise in any special time. If I thought they were worth more in a short time and were taking interest and care with their work, I was always glad to reciprocate in turn without their asking. I found this worked well with some, but that a great deal of ingratitude was shown by most. The worst feature with our young people, and you might drop some of the elderly men in with them, is the unfortunate night owling. Those that practise it are unfit for their labors or to do justice to themselves or their employers. I could write a volume on the shortcomings of various types, and my advice to all apprentices, as well as journeymen, if you want to be preëminent and successful with your work, keep clear from sporting of any kind and you will never regret it. If you can't trust yourselves, how do you expect others to trust you? HERMAN FLETCHER.

A newspaper statement from Ottawa is to the effect that 27 Canadian boards of trade have united in a memorial to the Government urging the deepening from 14 to 20 feet, also the widening of the Welland Canal connecting Lakes Erie and Ontario. The present canal is said to have cost the Dominion over $26,000,000.

In the course of an elaborate inspection trip over the New York, New Haven & Hartford Railroad, to be made under the supervision of John F. Stevens, formerly chief engineer of the Panama canal, among other valuable data to be obtained "every bridge over the system will be measured as to its hight and tensile strength," according to a New York daily paper.

AMERICAN MACHINIST

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The Jarno Taper

We have been asked occasionally, "What is the Jarno taper?"

Eighteen years ago Jarno, in one of his interesting series of contributions to this journal, discussed among other shop matters the confusion then existing in lathe-center tapers and sizes. He told of one shop having a few hundred lathes, comprising 60 kinds and sizes from 20 makers, who used no less than 23 different tapers in their product. He stated that two of these makers used six tapers each, and that they even put different tapers in lathes of the same kind and size. Later he discovered another tool builder who had in his lathe 10 different rates of taper. After discussing some of the causes leading to the adoption by various shops of so many standards for tapers and presenting some of the reasons for the numerous departures from alleged standards, he proposed a system as follows:

Let the rate of taper be 1 in 20, or 0.05 inch per inch. Let the tapers be numbered 1, 2, 3, and so on. Then the number of the taper will be the number of tenths of an inch in diameter at the small end, the number of eighths of an inch at the large end, and the number of halves of an inch in length or depth. For example: No. 1 taper would measure one-tenth inch diameter at the small end, one-eighth inch at the large end, and one-half inch in length or depth.

In this system, as will be observed, the number of the taper means something definite; for, with the number given, the end diameters and length are known immediately. Thus, if the No. 8 Jarno taper is referred to, it is known at once that the small diameter is 0.8 inch, the large end 1 inch and the length 4 inches. Further, the length can be derived from the diameter at either end, it being always five times the small diameter or four times the large; or, with the length known, by dividing by five the diameter of the small end is obtained, while dividing by four gives the large diameter. In short, with one of the three dimensions given the others are known immediately, as is also the number of the taper.

The advantages of the Jarno system of tapers were fully presented by its originator in his articles of nearly 20 years ago, and since that time others have indorsed his ideas and recommended the general adoption of the system. However, when the manufacturers who recognized the necessity for doing away with the chaotic state of affairs then existing in regard to tapers commenced simplifying the situation by adhering to some particular standard, the Morse and the Brown & Sharpe tapers were the ones most commonly adopted, and these are the tapers used today by the majority of American tool builders. Thus we find in the spindles of most lathes and in drill spindles taper holes made to the Morse dimensions established in the late '60s, when facilities for making and testing tools and gages were not of as precise a character as they are now, the result being that none of the tapers Nos. 1 to 6 inclusive is exactly to a standard of five-eighths inch per foot, the different sizes in the series actually tapering from 0.600 to 0.630 inch per foot. Milling-machine builders in the majority of cases use the Brown & Sharpe taper, which is one-half inch to the foot, with the exception of No. 10, which has a taper per foot of 0.5161 inch.

While the two tapers referred to above are the ones quite generally employed by our tool builders, there are, nevertheless, a number of manufacturers who have adopted the Jarno system with its taper of 0.6 inch per foot and its generally convenient features. One of these firms is the Pratt & Whitney Company, which is making wide use of this taper—in fact, applying it to all new designs of machines as well as to its regular line of lathes, Lincoln millers and profilers. Thus, in the spindle of the 10-inch toolmakers' lathe built by this concern a No. 6 Jarno taper hole is formed; the 13-, 14- and 16-inch lathe spindles are bored respectively to Nos. 11, 13 and 16 Jarno tapers; the No. 3 bench lathe takes No. 4 Jarno centers. Similarly, the spindles of the various sizes of profilers and Lincoln millers are provided with taper holes conforming to this system. If anyone not familiar with the system wishes to test its simplicity, let him take any one of the taper numbers just referred to and see how readily he may obtain the three necessary dimensions by simply bearing in mind the three simple factors, "halves," "eighths" and "tenths." Taking, say, the No. 6 taper used in the case of the 10-inch toolmakers' lathe, we have at once six-eighths (¾) as the large diameter, six-tenths (0.6) as the small diameter, six halves (3 inches) as the length. Or, in the case of the 16-inch lathe with its No. 16 taper, we mentally find the dimensions of the latter to be as follows: Diameter at large end, 2 inches; diameter at small end, 1.6 inches; length, 8 inches.

The Norton Grinding Company is another prominent concern using the Jarno taper, C. H. Norton having adopted it when he first designed the line of grinders built by that company. We understand that the Remington Arms Company, of Ilion, N. Y., also has adopted this taper as the standard throughout its shops; and presumably there are a number of other manufacturers, whose practice in regard to this matter we are unacquainted with, who are making use of the system.

In this connection it is of interest to note that for many years the F. E. Reed Company has used in its lathe spindles centers having a taper of 1 in 20, or 0.6 inch per foot, which is the same rate of taper as the Jarno. In fact, this company had been using this 1 in 20 taper for some

years when Jarno proposed his system of sizes. However, in the Reed lathes the size at the small end of the taper hole is governed entirely by the size of the straight hole bored through the live spindle; and while in several cases the small-end diameters approximate closely Jarno sizes, the lengths in most instances are somewhat less than the Jarno system provides for.

We believe that the foregoing particulars should be of interest to machine-tool constructors and users, and that especially among the younger class of mechanics there are many who will read here for the first time the details of the Jarno taper. We believe also that the features of this taper may be unfamiliar to quite a number of older readers. While in conversation with a tool manufacturer recently the writer was asked about this taper and was told that a little time before a certain machine had been ordered for the shop, and that upon the proprietor learning that the spindles were bored to the Jarno taper, he immediately ordered them rebored to one of the other standards. He said he had never heard of the Jarno taper until it was mentioned in connection with the new machine he had purchased; and, not knowing anything about it, he had ordered the change in the taper, which, he stated, he should not have done had he taken pains at the time to find out just what the Jarno taper really was.

It is certainly a little peculiar that, in view of the general handiness of this system, it has not been more commonly adopted. It would seem that its simplicity ought to appeal to designers, manufacturers and shop men, especially where new work is being undertaken, and where there is therefore less reason than might otherwise be the case for adhering to some previously used taper.

Destruction of the Earl's Court Wheel

Not all engineering undertakings are constructive. Now and then a work of demolition is accomplished involving the outlay of almost as much time, ingenuity and judgment as were expended in the original work of construction. An interesting undertaking of this character was recently carried out in London when the great wheel at Earl's Court was taken down, about four months' actual working time being required in the work of destruction. This wheel, which many American visitors to London will readily recall, was erected 12 years ago. It was a pin-jointed structure 300 feet in diameter and weighing 1000 tons, the uprights upon which it was mounted weighing 400 tons more. Owing to the location of the wheel between two railway lines over one of which its periphery projected, destruction by dynamite or overthrowing by other means was out of the question, and each part had to be lowered separately. How the work was proceeded with is presented in detail in an article in our London contemporary, *Engineering*, which shows by diagrams and half-tones the progress of the work from start to finish.

The inner portion of the structural-steel periphery of the wheel was connected to the axle by eighty 29/16-inch steel spokes, and another eighty spokes crossed in plan served as wind bracing. The outer members forming the true periphery, for carrying the 40 cars, were connected to the inner periphery by radial struts built up of 12x12-inch channels, and angle-iron lattice work and heavy steel diagonals served as bracing between the outer and inner peripheries and between the opposite sides or faces of the wheel between which the cars were suspended. In planning a method of taking the wheel to pieces, the structure was considered as made up of two semicircular arches with the upper one carried by the lower, which was in turn suspended from the axle; it was decided therefore to demolish the wheel from the top after the removal of the cars. The latter operation was performed without throwing the wheel out of balance by more than the weight of one car, by taking off the lower car, then turning the wheel halfway around and removing a second car, then turning a quarter way and removing car No. 11, turning again 180 degrees to remove car 31, and so on.

Before cutting through the wheel at the vertex, two massive radial struts made up of 12x12-inch pine sticks were built in between the axle and the periphery at approximately 90 degrees apart, to serve as supports at either side of the point where the wheel was to be cut. The struts were firmly braced and tied together by wire rope, and the wheel was securely lashed to its standards with the section included between the struts directly over the axle. The work of removing the plates in the periphery at either side of the top center was then started. It was found upon attempting to remove the steel rods forming the wind bracing that these had so rusted in that it was impossible to start them; and they had to be cut in two with hack saws. In fact, the whole of the 160 rods 3¼ inches in diameter, and a similar number of 29/16-inch spokes and 2½-inch bars, had to be sawn through in the process of demolishing the wheel. Although the sawing was done under awkward conditions, the 3¼-inch rods were severed in about 2½ hours on the average. As the work of removing the periphery was carried along, each piece as removed had to be lowered a distance of 300 feet to the ground, the demolition of the 200-foot section between the upper ends of the two temporary struts taking about 24 days. The struts were then removed piecemeal and the work of dismantling the wheel periphery was carried along on both sides so as to maintain a balance. After reaching the points where the wheel was lashed to the standards, the suspension rods were cut at the axle, and the remainder of the wheel allowed to drop.

The axle, which was 8 feet in diameter by 40 feet long, weighing with its plummer blocks about 60 tons, was thrown bodily to the ground by first jacking up the blocks, placing rollers underneath and attaching to each block wire ropes which led over pulleys on the standards and thence to the ground, where they were connected with tackle capable of giving a horizontal pull of 30 tons on the blocks above. A cushion of wood chips 12 feet thick covered with heavy tarpaulins was provided to receive the axle, and the latter in its fall passed completely through the cushion and entered the ground to a depth of several feet.

The eight legs forming the standards for the axle were of box-girder section 4 feet square. The upper ends of these uprights were taken down plate by plate, the lower portions being dropped in 40-foot sections.

The Society for the Promotion of Engineering Education

The fifteenth annual meeting of this society will be held at the Case School of Applied Science, Cleveland, Ohio, July 1 to 3.

The membership includes both educators and consulting engineers, one-sixth of the members belonging to the latter class, and the society desires more members of both classes.

German Iron and Steel

According to the latest reports collected by the Berlin correspondent of the London *Times* with regard to the prospects of the German iron and steel industry, there has never at any previous time been such a stream of orders as is now pouring into the various works, and specially extended periods of delivery have generally to be enforced. The steel syndicate, for example, has already got enough orders on hand to last well on into the autumn, if not beyond that term. The raw-iron syndicate of Düsseldorf on April 1 had orders for 735,000 tons of iron on hand. With regard to the discrepancy between German and English prices for smelting iron, the steel syndicate has decided not to come down to the lower level of rates on the English market, notwithstanding the apprehensions which have been expressed in various quarters that this course may result in a loss of custom. At home, however, the individual works were allowed the option of enforcing or not, as they pleased, the additional surcharge of 3 marks (71.4 cents) per ton on smelting iron.

New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A Direct-driven Electrical Drill Press

As will be seen, this machine is a departure from other electric-drive drills in the mounting of the motor directly on the drill spindle. It is designed for small work, up to ¼-inch drills, the spindle having a movement of 2¾ inches and the table 5 inches, while the entire hight of machine is only 27 inches. The bench

DIRECT DRIVEN ELECTRIC DRILL

space required is 12x12 inches and it weighs but 75 pounds.

The spindle and sleeve have a dust-proof bearing, both spindle and shaft being hardened. The spindle is, of course, counterbalanced. The feed is by a steel rack and pinion, and the length of the feeding lever can be regulated to suit the drill being used.

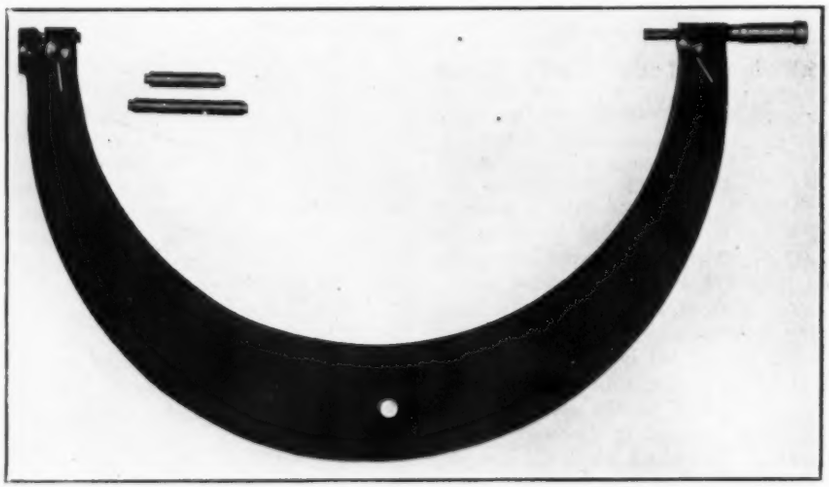
The motor is of the direct-current type, wound for either 110 or 220 volts, and can be run from any lamp socket. It is thoroughly under control at all times, can be started or stopped instantly and gives a range of speed from 800 to 3000 revolutions per minute, divided into 24 steps so as to give the proper speed for various sizes of drills and different classes of material.

The motor has a ball-bearing thrust, hardened-copper commutators with mica insulation, adjustable carbon brushes, bronze bearings, large starting power, uses but little current, and has much to recommend it to any shop having work for a small drill.

It is patented and built by the Faure Electrical Works, Inc., Ossining, New York.

Large Micrometer Caliper

The half-tone illustrates a micrometer caliper made as required in sizes from 15 to 24 inches. These tools have a range of 3 inches by interchangeable anvils which are standard end-measure rods of 1, 2 and 3 inches in length. The anvil or rod is held by a split clamp in the frame and rests against the adjusting screw, with provision for wiping contacts. As will be seen, the method of resting the rod against the end not only permits easy wiping of the end before setting in place, but also allows the operator to tell, by holding to the light, whether the rod is properly seated or not. The end-measure rods are ⅜ inch diameter and the overhang is 2¼ inches at the most. The maker is the J. T. Slocomb Company, Providence, Rhode Island.



LARGE MICROMETER CALIPER

A Portable Shop Rack

The illustration shows a portable shop rack in which the middle shelf is adjustable up or down. As will be noted, the wheels are large, which permits the rack

PORTABLE SHOP RACK

to be moved easily. The casters are seated on ball bearings in cages, so that they are not easily lost. The ball bearings permit the casters to face readily in any direction. The axle is dead in order to allow it to turn corners readily.

This rack is made in two sizes, 20x26 inches and 24x32 inches, with tops and number of shelves to suit, by the New Britain Machine Company, New Britain, Connecticut.

Electric Bench Drill

The tool illustrated herewith is a portable, electrically driven, sensitive bench drill, operated by direct current, which may be obtained through an attaching plug from an ordinary electric-light socket. It is capable of drilling holes up to one-half inch diameter in metal. The friction-disk drive is arranged to compensate for wear automatically, the motor being pivotally suspended with a spring between the rear end of its frame and a bracket on the drill-press frame. The speed can be changed by moving the friction driving wheel axially, the range of variation being from 390 to 950 revolutions per minute. The total hight of the drill is 32 inches and weight complete 112 pounds. The spindle has a vertical movement of 10½ inches, that being the maximum distance from the table to the lower end of the spindle. The machine is made by the United States Electrical Tool Company, Cincinnati, Ohio.

ELECTRIC BENCH DRILL

Columbia University, of this city, announces a series of summer courses intended more especially for instructors and graduate students. The courses offered, which begin July 9, include lectures and laboratory practice in hydraulics, lectures in concrete steel structures, lectures and laboratory practice with gas engines, and lectures and laboratory practice in experimental engineering. Full particulars may be obtained from the secretary of the university.

Business Items

The Heald Machine Company, Worcester, Mass. has under construction a large addition to its factory. This is made necessary owing to the large increase in its business.

The new buildings for S. L. Allen & Company, Philadelphia, which are being designed and constructed by Dodge & Day, engineers and constructors, are being constructed entirely of re-inforced concrete.

The Dayton Pneumatic Tool Company, of Dayton, Ohio, has received a large order for "Dayton" pneumatic chipping and riveting hammers from Sweden. Orders have also recently been received for a number of tools for shipment to England, Italy and Canada, and this company reports a very satisfactory increase in foreign business.

Trade Catalogs

The Lunkenheimer Company, Cincinnati, Ohio. Booklet describing generator valves. Illustrated, 24 pages, 3½x6 inches, paper.

The Knecht Brothers Company, Cincinnati, Ohio. Pamphlet describing the Knecht sensitive drill. Illustrated, 12 pages, 3½x6 inches, paper.

Baldwin Locomotive Works, Philadelphia, Penn. Record No. 61, entitled "The Steam Locomotive of the Future." Illustrated, 36 pages, 6x9 inches, paper.

The General Pneumatic Tool Company, Montour Falls, N. Y. Bulletin No. 58, illustrating and describing electric traveling cranes. 20 pages, 8x11 inches, paper.

Lidgerwood Manufacturing Company, 96 Liberty street, New York. Pamphlet describing electric hoisting engines, direct current, 250 and 500 volts. Illustrated, 8 pages, 9x12 inches, paper.

Manufacturers

The Fort Worth & Denver Railway Company is enlarging its shops at Childress, Tex.

The Steel Fixture Manufacturing Company, Topeka, Kans., will erect a new machine shop.

The Ajax Manufacturing Company, Cleveland, Ohio, machine builders, will erect a new plant.

The Anchor Wire Fence Company, Stratford, Ont., is said to be planning to build a new factory.

A $25,000 addition will be built to the plant of the Smith Premier Typewriter Company, Syracuse, N. Y.

The Lansing (Mich.) Wheelbarrow Company has had plans prepared for a factory in Philadelphia.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York. Caliper list free. E.G.Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

We desire a few more machines or specialties to manufacture. Box 423, Troy, N. Y.

Machines designed and built. Walter S. McKinney, M. E. Broadway, Flushing, N. Y.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

C. W. Clifford, M. E., working and patent drawings and tracings. 643 N. 44th St., Philadelphia, Pa.

Wanted—To buy or lease small machine shop; state terms and equipment. Box 110, AMERICAN MACHINIST.

Special machinery built to order; let us estimate on your work. Capital Foundry and Machine Company, Frankfort, Ky.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Machinery concern, dividend-paying, high-rating, wants active hustling partner; must invest. "Machinery, Box 113, AMER. MACH.

We will do your manufacturing for you; well established and equipped foundry and machine shop. Emmet Mfg. Co., Waynesboro, Penn.

Well established concern will pay royalty for several good patented machines or tools to manufacture. Emmet Mfg. Co., Waynesboro, Penn.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—A mechanic thoroughly familiar with hack saw manufacturing, willing to back his knowledge with some capital. Address J. F. Goulart, 65 Bedford street, Boston.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

An old established firm with modern tools and equipment is desirous to communicate with an American firm to manufacture for them in Canada a line of light or medium weight machine work. Box 79, AM. MACH.

Manager or superintendent; practical, wide and successful experience, with good executive ability, desires correspondence from parties in need of an up-to-date, energetic and loyal man; all correspondence strictly confidential. Address Box 114, AMER. MACH.

Mechanical engineer with extensive experience on machinery and tools for the cold working of sheet metal, etc.; solicits correspondence from parties seeking a profitable machine to build, with or without services. Address "Press," care AMER. MACH.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th street.

Advice; mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

To manufacturers and others: a resident of Sydney, Australia, will be in New York early in July, desires to obtain a general agency or as representative; weighing appliances and mechanical goods a specialty; references and security if needed, pending arrival. Box 108, AMERICAN MACHINIST.

We have a special proposition for a few bright, energetic mechanics, such as foremen, draftsmen or machinists in different sections of the country; no canvassing or selling of any kind and while not interfering with your regular work pays well for the time taken; we want only practical men who can be depended on to give the little time required each week; further particulars on application. Box 102, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Experienced electric crane operator desires position; can come at once; reference given. Box 101, AMERICAN MACHINIST.

Patternmaker, technical and with years of practical experience wishes a position as instructor in patternmaking and molding. Box 82, AMERICAN MACHINIST.

A first-class designer of automatic and special machinery is open for engagement as mechanical engineer or chief draftsman. Box 104, AMERICAN MACHINIST.

Technical graduate, married, age, 26; now assistant to master mechanic in mill employing 400 people desires to make a change; familiar with compilation of estimates and reports, electrical and mechanical power distribution, office and drafting room practice and system, and building construction and maintenance, good corespondent; salary $1500. "Technical," Box 738, New Haven, Conn.

ILLINOIS

Mechanical superintendent of experience desires position with first-class machine manufacturers; have had fourteen years' experience in the shop and drafting room on high grade machinery and as superintendent; know how to design jigs, fixtures and tools for producing accurate work at a minimum cost. "Superintendent," Box 91, AM. MACH.

MASSACHUSETTS

An original and up to date man wants charge of a machine shop or department in New England, Massachusetts preferred; Boston references. Box 88, AMER. MACHINIST.

Mechanical draftsman with 4 years' drawing room and 3 years' machine shop experience desires to make a change; good references. Address Box 66, AMER. MACHINIST.

Toolroom foreman, acting as assistant superintendent of shop employing 200 men, manufacturing small accurate tools, desires change. Age 28; inventive and resourceful; references. Box 47, AMERICAN MACHINIST.

General superintendent desiring change solicits correspondence from concerns desiring the services of a practical mechanic who is a successful organizer and executive; unquestionable references as to ability and character. Box 451, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman wishes to change; four years' experience, technical. Box 74, AMERICAN MACHINIST.

Position as foundry foreman, up to date and a hustler well up on light and heavy work and molding machines. "T. R.," AM. M.

Wanted—Position as foreman; patternmaker having wide experience in electrical and general engineering patterns; can give first-class reference. Box 87. AMER. MACH.

Wanted by skilled mechanic with executive ability, position to supervise the construction and making of fine tools, jigs, fixtures and intricate machinery requiring minute accuracy; technical graduate; age 37; married; references given. Box 99, AMERICAN MACHINIST.

NEW YORK

Foundry foreman wants position; best of references. Address Box 154, Seneca Falls, N. Y.

Mechanical draftsman; 6 years of practical experience, wants a position. Box 89, AMERICAN MACHINIST.

General foreman or foreman at libe wide experience, systematic; cost reducer. Box 116, AMERICAN MACHIN ST.

Fine mechanic desires position in Greater New York, tool, die, or experimental work; splendid references. Box 115, AMER. MACH.

Draftsman; nine years' experience in shop and drafting room, technical education; desires position. Box 119, AMER. MACHINIST.

Mechanical draftsman; 9 years' shop and office work; general machinery; references; New York city position. Box 105, AM. MACH.

Position as toolroom foreman and designer by a machinist with good references and wide experience; latest modern methods; desires change. Box 120, AMERICAN MACHINIST.

A young tool and diemaker with 16 years' experience on tools, dies and experimental work; also held position as inspector, desires responsible position. Box 81, AMER. MACH.

A-1 machinist, German lathe hand; 39 years; 25 years' shop experience; at present foreman over Gisholt department in a big automobile plant, wishes to change. Box 107, AMERICAN MACHINIST.

Young American with good habits, naturally mechanical, with seven years' experience, designing light automatic and electrical machinery; very familiar with machine and pattern work, jigs, etc., wants position as assistant superintendent near New York or New England; salary a secondary consideration. Box 118, AMERICAN MACHINIST.

Young man, connected with several firms, desires to make a change; experienced in office management and buying, successful in advertising and selling, especially in mail order business, knows how to find market for goods; systematizer and up to date in methods; seeks permanent position with good future; would go anywhere. Box 112, AM. M.

OHIO

Tool desginer with extensive experience on special machinery and tools; at liberty soon. Box 111, AMERICAN MACHINIST.

PENNSYLVANIA

Experienced woman invites correspondence from manufacturers of machine tools, or in any mechanical line, with a view to position as publicity manager; thoroughly competent to handle printing, illustrating, and the preparation of copy. Box 103, AMER. MACHINIST.

M. E. graduate, hustler, good figurer, working from economical standpoint seeks position as chief draftsman or constructor in crane or agricultural machinery concern; first-class references; 8 years' experience; salary less than $140 not considered. Address Box 84, AMERICAN MACHINIST.

Manager of an up to date plant desires to change; competent office man, experienced in the detail of manufacture in the foundry, machine shop, pattern shop and drafting room; technical graduate, capable and original designer, intimately acquainted with all the operations of a corporation employing 7000 men; I present an opportunity for a successful business owner to shift some of his cares. Address 218 Locust St., Avalon, Pa.

WEST OF MISSISSIPPI

Professor of mechanical engineering in a State University is open for engagement during the Summer; broad experience in locomotive, steam and pumping engine practice. Address Box 117, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ALABAMA

Wanted—One toolmaker; one high-grade turret lathe man for bar and dry work; one expert wood working machinery man as inspector. De Loach Mill Mfg. Co., Bridgeport, Ala.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—A young man as draftsman; a man with some shop and drawing room experience on jigs and fixtures preferred. Address giving experience, references and salary expected. "P. G. C.," AMERICAN MACHINIST.

ILLINOIS

Large company building line of duplex direct-acting steam pumps and hydraulic machinery want a first-class head draftsman; good position for the right man; state experience, age, etc. Address Box 95, AM. MACH.

Wanted—First-class hustling general superintendent for machine works in middle west, employing one thousand men; open shop; splendid labor conditions; a good position for the right man; state experience. Address Box 96, AMERICAN MACHINIST.

Detail draftsman; one who has had experience on machine tool work preferred; preference also given Swedish, Danish or Norwegian technical graduates; state whether married or single, age, experience and salary expected. Address Box 64, AMER. MACHINIST.

INDIANA

Wanted—Foreman for assembling department of factory manufacturing gasolene engines. Box 16, AMERICAN MACHINIST.

IOWA

Wanted—Foreman for gray iron foundry employing from 20 to 30 molders; must be strictly non-union and thoroughly familiar with cupola practice; permanent position for right party, with excellent chance for advancement; town of 20,000 population; first-class public and normal schols; none but temperate married men need apply. Address Litchfield Mfg. Co., Waterloo, Ia.

MASSACHUSETTS

Wanted—Master mechanic for steel foundry located in New England; experience necessary on crane repairs, pumps and foundry machinery; good opportunity for a progressive man; state age and experience. Address "C. S. M.," AMERICAN MACHINIST.

Inspectors Wanted—Several inspectors for manufactured metal goods and tools; none but men who have had experience on systematized inspection; old established manufacturing plant in suburb of Boston; open shop; no labor troubles; steady work for the right men. Box 80, AMERICAN MACHINIST.

MISSOURI

Draftsman Wanted—Experienced in designing tools and jigs for automobile work. Kansas City Motor Car Company, Sheffield Station, Kansas City, Mo.

Wanted—Six first-class erecting machinists; also 3 gas engine erecting engineers; state references, experience, and salary expected. Box 35, AMERICAN MACHINIST.

Draftsman wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

Machinist wanted who has had experience in making and mounting metal patterns for molding machine work; steady work and good wages to quick accurate man. Box 93, AM. M.

Wanted—First-class mechanical draftsmen by large firm near New York; draftsmen familiar with metallurgical work preferred; state experience, age and salary expected. Address "Metallurgy," AMERICAN MACHINIST.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Machinist and toolmaker wanted, with broad experience as working foreman over two or three men; applicants must be able to produce labor-saving tools for working rolled and cast brass, and be able to work from drawings; in applying state age and past experience; good opening is offered for a first-class man. Box 92, AMERICAN MACHINIST.

NEW YORK

Wanted—A metal pattern maker in machine shop, vicinity Albany, N. Y. Apply stating salary expected and experience to Box 97, AMERICAN MACHINIST.

Thoroughly experienced machine shop or metal goods factory cost clerk who has had experience on estimating; can read drawings and who is familiar with materials; only A-1 men need reply stating experience fully and salary expected; confidential. Box 90, AM. M.

Non-union toolmakers accustomed to small accurate work; 42 cents per hour, 54 hours per week; non-union screw machine hands, accustomed to Brown & Sharpe hand and automatic machines, 35c. per hour, 54 hours per week; machinists accustomed to lathe, drill press and bench work, 30c. per hour, 54 hours per week; steady employment guaranteed to first-class men. Apply Jones Speedometer Factory, New Rochelle, New York.

Wanted—Shop foreman; a first-class man by a company manufacturing heavy printing machinery, employing 200 men, near New York City, in a new and modern plant; must be a thorough mechanic, a man of ability, know how to take direct charge of his men and have a good knowledge of how to manufacture in this line; good position for a responsible man with a young and growing company. Apply room 810, 41 Park Row, New York City

OHIO

Wanted—Experienced punch and shear draftsman; state qualifications, age, and salary expected. Box 70, AMER. MACHINIST.

Wanted—Several draftsmen familiar with steam hammer designing; state age, experience, and salary expected. Box 71, AM. M.

Wanted—First-class die and toolmakers on bench and vise work on forming, embossing and cutting dies; steady employment, first-class wages; excellent conditions; no labor troubles. Box 37, AMERICAN MACHINIST.

Wanted—A first-class general foreman; one with electrical experience preferred; must be thoroughly up to date and able to handle men and jobs so as to insure maximum output; a splendid opening for the right man. Box 98, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Lathe, planer and boring mill hands. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Competent mechanical draftsman, general experience, on new construction work; state particulars and wages expected; location Western Penna. Box 83, AM. MACH.

Wanted—Experienced mechanical and electrical draftsmen on electrical machines, apparatus and instruments; only first-class men need apply; state experience and salary pected. Address Box 106, AMER. MACHINIST.

Wanted—An energetic superintendent for a plant having pattern shop, foundry and machine shop, employing 100 men, and building machine tools and other specialties; a good opportunity to get into a growing business; must be capable of handling men, and getting out good work at reasonable cost; position permanent for a first-class man. Box 50, AMERICAN MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

VERMONT

Wanted—Draftsman; one with experience on textile machinery preferred; permanent place. Box 94, AMERICAN MACHINIST.

WISCONSIN

First-class operator for setting up jobs on Cleveland automatic and other make screw machines. Address Box 100, AMER. MACH.

Wanted—First-class general foreman, for large machine and erecting shop, building heavy machinery; liberal pay to one who can produce results; do not apply unless you can show good record. "X. Y. Z.," AM. MACH.

For Sale

Test Indicators. H. A. Lowe, Cleveland, O.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Patent, patterns and working drawings covering stone saw gages. Box 85, AMERICAN MACHINIST.

Two hydraulic presses, will take in material 35"x35". Address Shartle Brothers Machine Company, Middletown, O.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, Ohio.

For Sale—Ten volume library covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

For Sale—One branch of a well established line of machine tools in the middle west with good foreign and domestic agents and five months' orders ahead. Address "Special," AMERICAN MACHINIST.

For Sale—Part interest in a ring traveler manufacturing business in eastern Massachusetts; splendidly equipped plant ready for operation; more capital required for starting. Box 109, AMERICAN MACHINIST.

For Sale—60 h.p. Bigelow return tube boiler; A-1 condition; 80 lb. pressure allowed by Hartford Steam Boiler Insurance Company; just removed to install larger one. West Haven Mfg. Co., New Haven, Conn.

For Sale—Two Geometric die heads with chasers, lot of large and small chucks, tapping attachment, lot of drills and reamers, bench shear and other fine tools, all first-class; will exchange for second-hand lathe. Box 707, AMERICAN MACHINIST.

Patent No. 845,994 "Safety Device for Firearms," March 5, 1907 for sale; price $300. Patent No. 848,280 "Time Control of Automatic Temperature Regulators," March 26, 1907, for sale; price on application. Address Frank Beckwith, Evanston, Wyoming.

For Sale—Complete electroplating outfit, including one 500 ampere dynamo, one 5 and one 10 horse-power motor 500 volt direct current; 3 cedar and 3 iron tanks, together with nickel, brass, bronze and copper anodes rheostats, switches, grinding and polishing lathes, carborundum, bull neck, canvas, felt and cotton wheels, power press, wood pulleys, shafting, hangers, belting and supplies. W. T. Coulter, 201 Outlook Bldg., Columbus, Ohio.

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Abrasive Material Co., Phila., Pa.
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Cortland Cor. Wheel Co., Cortland, N. Y.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

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Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arches, Boiler Door

McLeod & Henry Co., Troy, N. Y.

Architects

Dodge & Day, Philadelphia, Pa.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Baird Machine Co., Oakville, Ct.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chain

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Blowers

American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Bros. Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., Ntw York.
Soltmann, E. G., New York.

Blue Print Paper

Soltmann, E. G., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Boiler Setting

McLeod & Henry Co., Troy, N. Y.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, Ohio.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Philadelphia, Pa.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

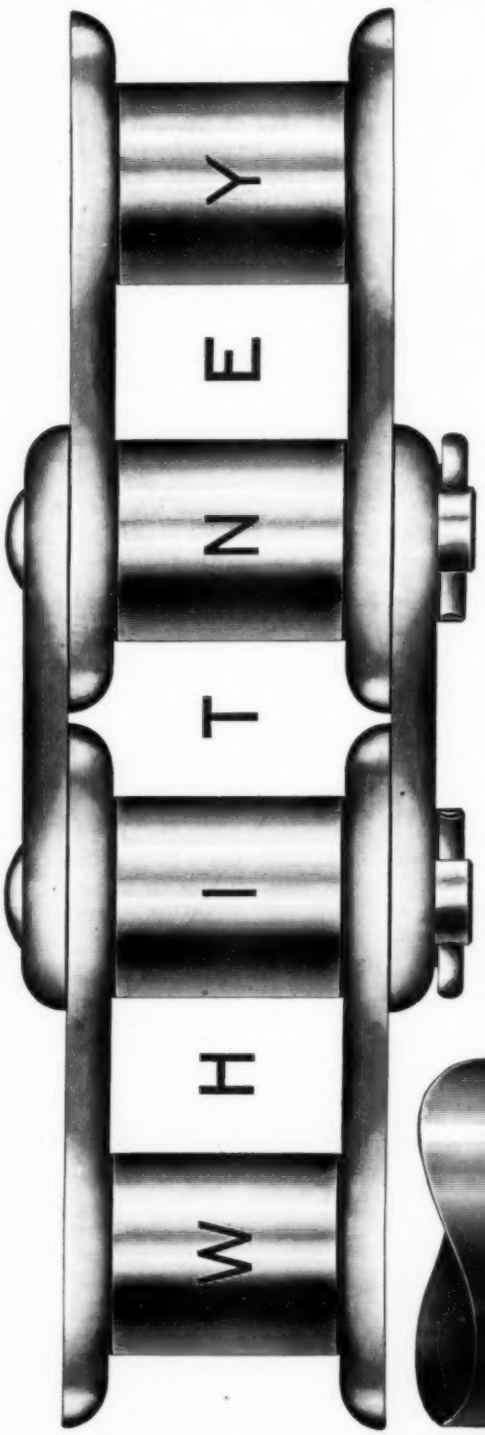
Boring and Turning Mills, Vertical

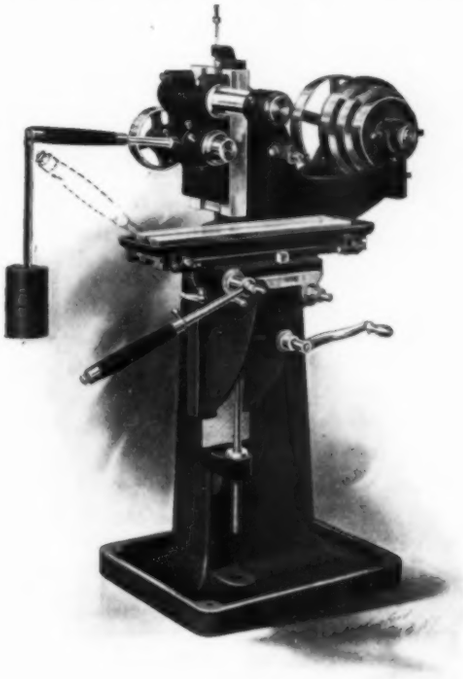
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.

"WHITNEY" CHAINS

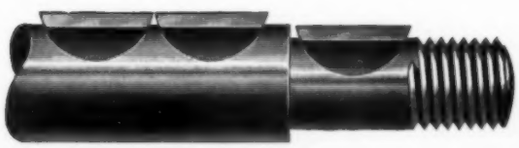
Hand (feed) Milling Machines

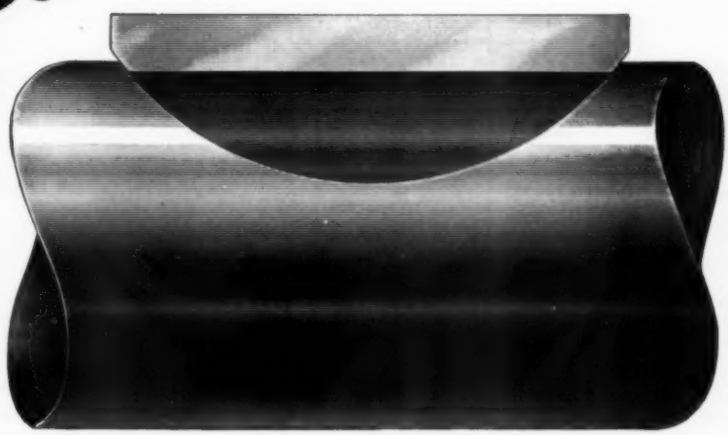
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

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Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote
Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction
Electric Controller & Supply Co., Cleveland, O.

Brazing
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Brazing and Tempering Powders
Phillips, Lafitte Co., Phila., Pa.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson Mass.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels

Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Manufacturers Foundry Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

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Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.

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Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

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Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co. Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co. Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor, Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Woods Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic
Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic
Sturtevant Co., B. F., Hyde Park, Mass.

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Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Slushing
Warren Bros. Co., Boston, Mass.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

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Blanchard Machine Co., Boston, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Ct.

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Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
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Link-Belt Co., Philadelphia, Pa.

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Niles-Bement-Pond Co., New York.

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National Brake & Clutch Co., Boston, Mass.

Corundum
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Veeder Mfg. Co., Hartford, Ct.

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Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
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Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

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Ingersoll-Rand Co., New York.

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Almond Mfg. Co., T. R., Brooklyn, N. Y.
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Chisholm & Moore Mfg. Co., Cleveland, O.
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Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

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Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
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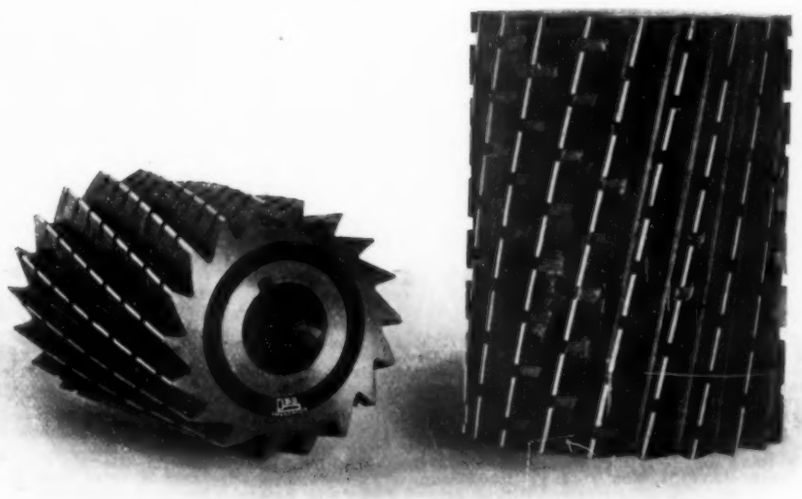

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Maris Bros., Philadelphia, Pa.
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Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Phila., Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

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Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
National Tool Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

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Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

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Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

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Veeder Mfg. Co., Hartford, Ct.

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American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York City.
Safety Emery Wheel Co., Springfield, Ohio.

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American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.
Risdon Tool Works, Waterbury, Conn.

Dies, Sub-Press
Risdon Tool Works, Waterbury, Conn.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

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Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
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New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
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Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

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Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

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Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.

Drill Speeder
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Sturtevant Co., B. F., Hyde Park, Mass.

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Northern Elec. Mfg. Co., Madison, Wis.
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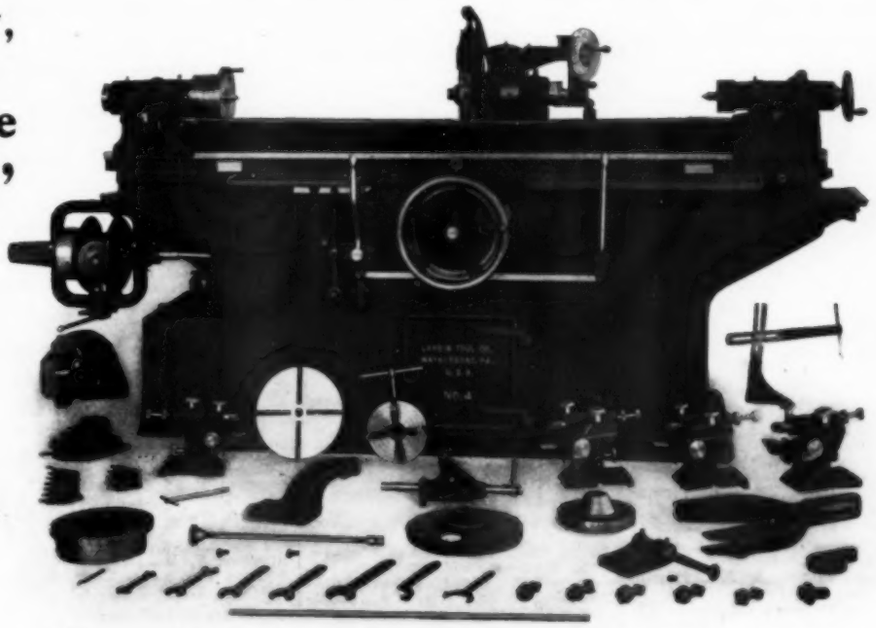

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Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
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Link-Belt Co., Philadelphia, Pa.
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See Grinding Wheels

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
International Specialty Co., Detroit, Mich.
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Standard Tool Co., Cleveland, O.
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Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

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Thompson, Hugh L., Waterbury, Conn.

Engineers, Mechanical and Electrical
Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

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Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

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Remington Oil Engine Co., Stamford, Conn.

Engines, Marine
Remington Oil Engine Co., Stamford, Conn.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Eng. Co., Stamford, Conn.

Engines, Oil
Remington Oil Eng. Co., Stamford, Conn.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers
Bormay Engraving Co., New York.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Machinery Exchange, Boston, Mass.
Philadelphia Bourse, Phila., Pa.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment
Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps
American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filler, Iron
Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Fire Brick
McLeod & Henry Co., Troy, N. Y.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery
The Scranton & Co., New Haven, Conn.

Forgings, Drop
Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.

Forgings, Drop—*Continued.*
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic
Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine
Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel
Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Crescent Forgings Co, Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
McInnes Steel Co., Corry, Pa.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash Company, Geo., New York.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester, City, N. Y.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co, J., East Boston, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gas Blowers and Exhausters
Sturtevant Co., B. F., Hyde Park, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Morse, Williams & Co., Phila., Pa.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Chicago, Ill.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co, Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.

2 1-2 x 26-inch Open Turret Lathe

A New Machine Which Has a Cross-feeding Turret and Is Adapted to Machining Bar Material, Forgings and Castings

SPECIAL CORRESPONDENCE

The accompanying half-tones and line engravings illustrate a new turret lathe designed and built by the Pratt & Whitney Company, Hartford, Conn. This machine has a geared head operated by a constant-speed driving shaft and is equipped with a cross-feeding turret. It is adapted for handling work up to 2½ inches diameter by 26 inches long and will machine castings and forgings up to 14 inches diameter.

The Head and Spindle

The machine as a whole is clearly represented in Fig. 1, which shows the design of the one-piece bed and pan, the method of attaching the head and the appearance of the turret and its carriage. The internal mechanism of the head is shown in Fig. 2. The steel spindle is of stiff proportions and runs in bronze boxes split and externally tapered to fit conical seats in the head, thus allowing spindle wear to be compensated for by slightly adjusting the nuts at each end of the boxes. The thrust of the spindle is against an additional upright formed integrally with the head casting, which insures against any springing tendency of the spindle under heavy end-cutting strains. The provision made for taking up wear at the thrust bearing is indicated in Fig. 2. The spindle is ground and lapped so as to afford a smooth running bearing, suitable for high peripheral speeds; its front end is ground externally and internally while it is running in its bearings.

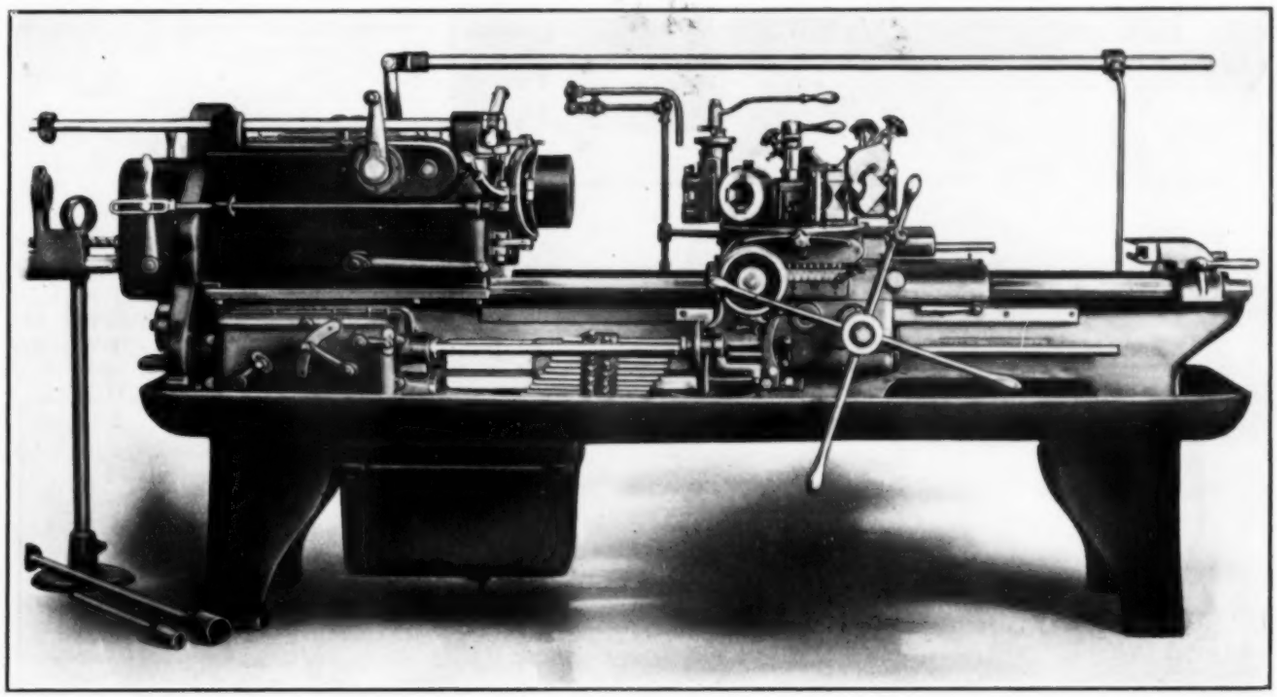

FIG. 1. 2½X26-INCH OPEN TURRET LATHE

The Driving Mechanism

The constant-speed drive, which may be operated either by belt or motor, is clearly shown in the engraving. On the main shaft at the rear of the head are fixed four gears of different diameters which engage with gears loosely mounted on the shaft directly below. Between these latter gears are secured friction clutches controlled by two grooved cams which may be operated by means of a handle at the front of the head to engage any one of the four loose gears. Between this shaft and the spindle is another shaft carrying gears which are placed at either side of a friction clutch and mesh with the two main gears secured to the spindle. The clutch on this shorter shaft is operated by the horizontal lever at the front of the head. Through this system of gearing, eight speed changes are derived for the spindle; by using the two-speed countershaft this number may be doubled. The spindle-reversing gearing is driven from the large gear at the left-hand end of the case.

Speed Control and Lubrication

The grooved cams which control the friction clutches are so arranged that it is impossible to connect more than one set of gearing with the work spindle and driving shaft at the same time. All of the controlling levers and connections are so placed as to be conveniently operated by the workman from the front of the machine while watching his tools; furthermore, the spindle may be instantly stopped by movement of any lever on the headstock. The gears are of ample width and heavy pitch; as the head is of box construction, it permits of their running continually in oil, thus assuring proper lubrication. In addition, the various spindle bearings are independently lubricated from the inside. Where a motor drive is required for the machine the motor is preferably bolted directly to the top of the head, although it may be placed elsewhere and connected by belt to the machine when so preferred. The driving pulley shown is 14 inches diameter and takes a 3-inch belt. The countershaft pulley belted to the driver is 18x3 inches and the counter speeds 340 and 300 revolutions per minute.

The Rod Chuck

The chuck for holding bar work has a powerful grip and may be operated while

the machine is running, by means of a lever and swinging link mounted as indicated in Fig. 1, at the forward end of the headstock. The various parts of the chuck are hardened and the jaws as well as the cylindrical moving members are ground. The jaws will handle stock from 1/16 inch over size to 1/16 under size, and in all cases a parallel grip is maintained. The chuck is shown closed in the sectional drawing Fig. 3 and taken apart in the half-tone Fig. 4, where each detail is brought out plainly. An examination of the former engraving will make the construction clear and show how the jaws are supported up to their outer ends to secure rigidity, which is needed especially when forming work by means of cross-slide tools.

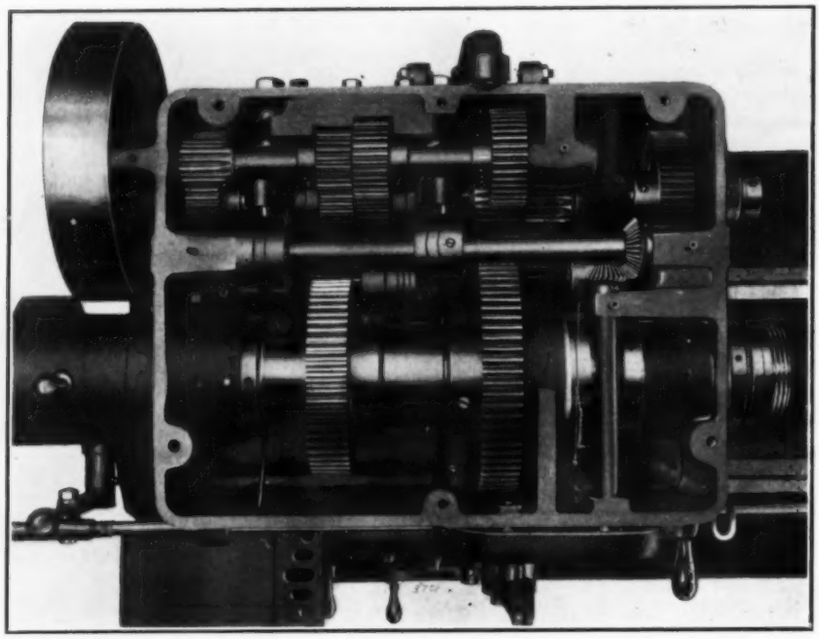

FIG. 2. INTERIOR OF HEAD

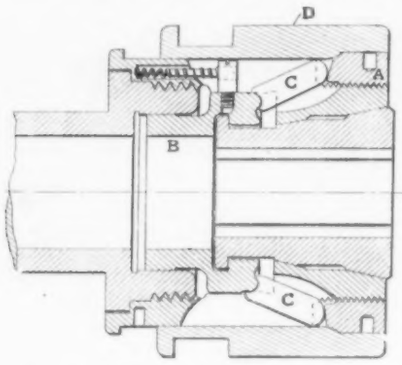

FIG. 3. SECTIONAL VIEW OF ROD CHUCK

Operation of the Chuck

It will be noticed that the chuck body which screws on to the spindle nose is threaded externally at its outer end to receive an adjustable ring *A* and carries at its inner end a sleeve *B* whose rear portion fits the mouth of the spindle while its larger end is recessed to receive the hooked ends of the jaws. Between *A* and *B* is placed a series of dogs or fingers *C* which, when sleeve *D* is moved forward to the closed position indicated, are forced slightly toward the center and rear by the inclined surfaces shown, causing sleeve *B* to draw the jaws back in their conical seats and grip them tight on the stock. When the operating sleeve *D* is moved toward the rear of the chuck body its enlarged mouth allows the outer ends of members *C* to swing outward sufficiently to permit the jaws to be moved forward in their seats, by the action of the springs behind *B*, and to be released from the work.

Adjustment for different diameters is by means of the threaded ring *A*. To remove the jaws, the outer ring *D* is moved to the left, and ring *A* unscrewed a few turns. The whole chuck can be readily removed from the spindle when a combination chuck or a special face plate for castings is to be substituted.

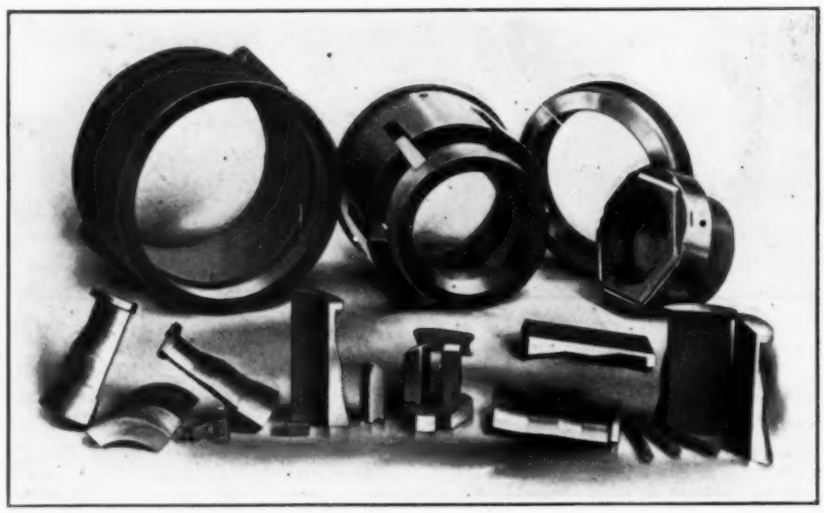

FIG. 4. CHUCK PARTS

The Stock Feed

The mechanism for feeding bar stock will handle either finished or rough material, of round, square, or other section. The general arrangement is shown in Fig. 5, the vertical operating lever represented in this drawing by dotted lines being seen also in Fig. 1. As will be noticed, the lever is connected by a link with the chuck operating lever, and when the latter is thrown over in opening the jaws, the clutch *A*, Fig. 5, together with the coarse-pitch feeding screw *B*, is moved to the right until it engages with the clutch on the face of the gear *C*, which is in mesh with a gear *D* on the rear end of the work spindle; this latter gear is positively rotated in one direction only. Immediately upon the clutch *A* being engaged with the clutch on gear *C* the feeding screw starts, causing the rod follower *E* to bring the bar of stock forward.

The Stock Stop

The movement of the bar is arrested at any predetermined point by an adjustable swinging stop in front of the chuck, which stop consists of a stiff arm that is mounted on a bar carrying an adjustable stop ring and adapted to slide longitudinally in brackets cast on the top of the head, this arrangement permitting the stop when not in use to be swung up and slid back to the position indicated in Fig. 1, where it is out of the way of the turret tools. The effect of the resistance of the stop to further advance of the bar is to cause follower *E* to become stationary and the revolving screw *B* with its clutch *A* to release itself automatically from the clutch on the face of gear *C*. When the follower bar has traveled its full distance, i.e., 26 inches, lever *F* is utilized to slide the feed screw to the left,

bringing its clutch into engagement with a corresponding clutch on a gear operating in the reverse direction, which returns the follower to its original position, where it is automatically disengaged in the same manner as when it has completed its forward movement. A follower bar is used for short pieces of stock, which enables them to be handled as conveniently as long bars, and at the same time serves to keep such pieces concentric with the spindle.

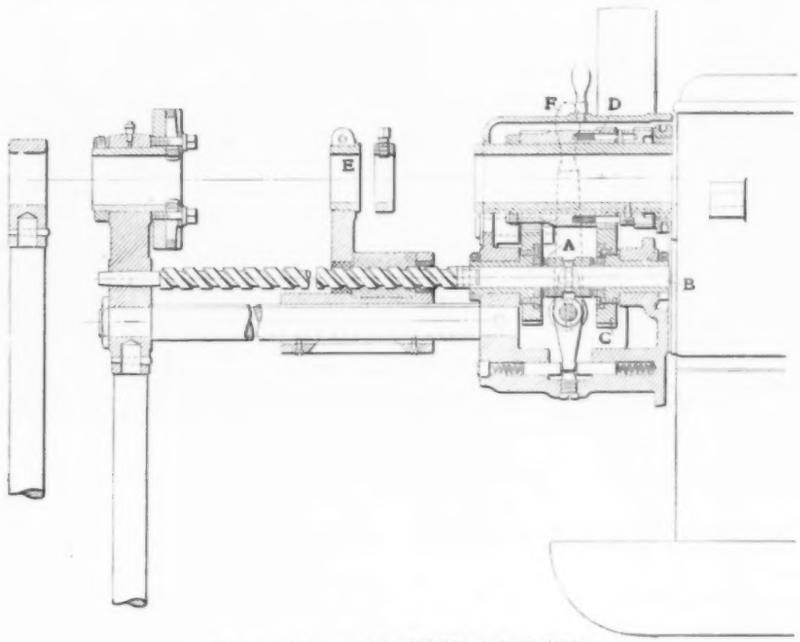

FIG. 5. THE STOCK-FEEDING MECHANISM

The Turret and Locking Bolt

The turret proper revolves about a large central conical stud held firmly in the cross slide; the binding device, as shown in Fig. 6, permitting long bars to pass through. The locking bolt, which is horizontal and adapted to engage the turret directly under the cutting tool, is hardened, ground, and accurately fitted to the cross slide and provided with means for taking up wear without disturbing any other member. In addition to side gibs there are provided two straps for insuring against any upward movement. The construction also permits of a long, heavy spring being used for positively locating the turret. Indexing is automatically accomplished when the carriage is run back, although when desired it is possible to rotate the turret directly by hand to any position. Indexing can furthermore be accomplished at all positions of the cross slide.

The Carriage and Its Stops

The carriage, which takes a long bearing on V's of generous proportions, is provided with gibs extending its full length, and also with a binder permitting the slide to be clamped firmly to the bed when using the cross slide for forming or while cutting off stock. The power longitudinal feed is positive in both directions, the feed shaft being driven direct from the work spindle. There are six changes of feed, any one of which may be instantly brought into operation by movement of a lever which actuates a sliding key, thus permitting changes to be made without stopping the work spindle.

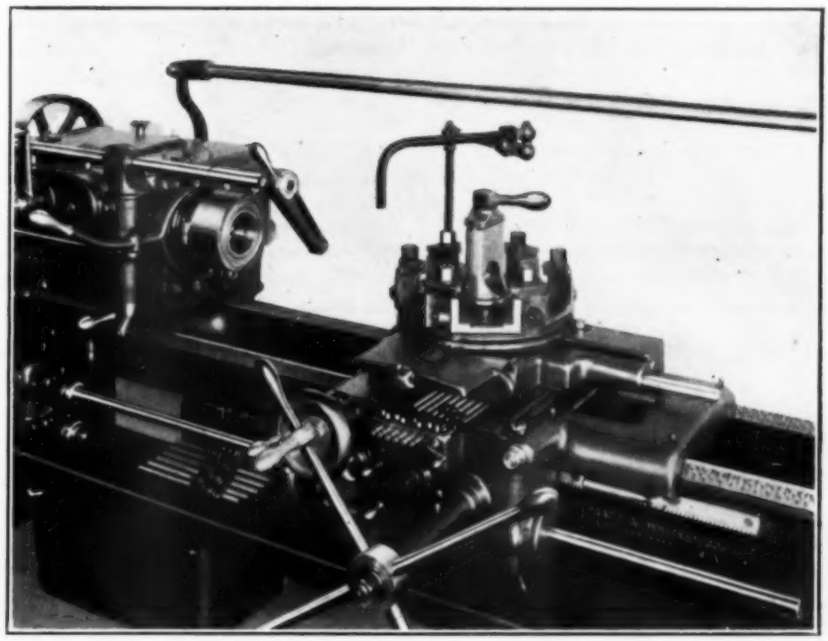

FIG. 6. TURRET SLIDES AND SYSTEM OF STOPS

The apron carries a system of worm and spur gears, running in oil, one of the latter gears meshing with a rack which is inverted, thus preventing clogging with chips, and located well under the edge of the bed to obviate any twisting tendency of the carriage.

There are six automatic longitudinal stops and six supplementary stops, all adjustable for length, which give two positions for each turret tool; or all twelve stops may be used for one or all tools in the turret, the combinations thus obtained making it possible to cover effectually the requirements on the various classes of work. The stops are held in a heavy steel bracket which, as indicated in Fig. 6, may be adjusted along the front of the bed and clamped where desired.

Operation of the Stops

On the base of the turret is formed a cam against which is a roller mounted on a rack, which latter, by means of a pinion and shaft, swings an arm into line with the six automatic stops in the bracket referred to. The stop-engaging arm is always backed up by the knock-off block, so that any pressure put on the arm by power or by the operator is transferred to this member, and any tendency toward springing the lighter parts of the stop mechanism is avoided. By releasing a locking bolt, the arm may be swung in line with any of the automatic or supplementary stops.

Both series of stops work in conjunction with the power feed, and either will cause the knock-off block to perform its function of stopping the movement of the longitudinal slide at the desired point. The power feed may also be disengaged by a movement to the right of the lever on the apron. The total backward movement may be short or long, depending upon the nature of the work, the back stop being set as conditions require.

The supplementary stops are of service when the regular stops have been previously adjusted to suit a long job, and it is desired to run through a few special pieces of work. The automatic stops

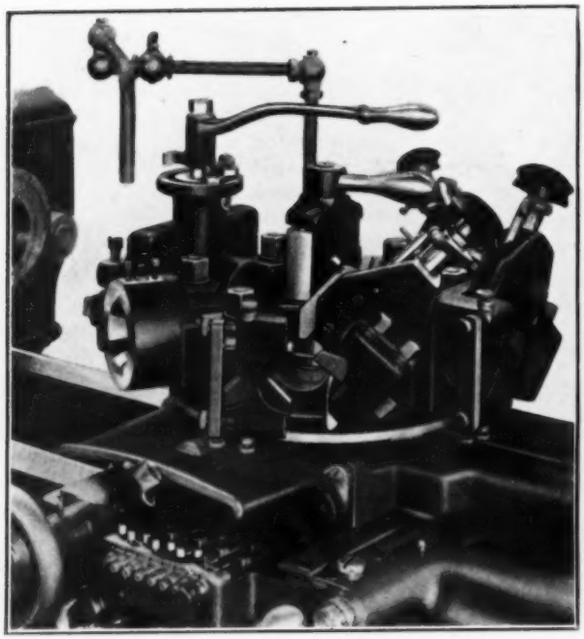

FIG. 7. TOOLS FOR BAR STOCK

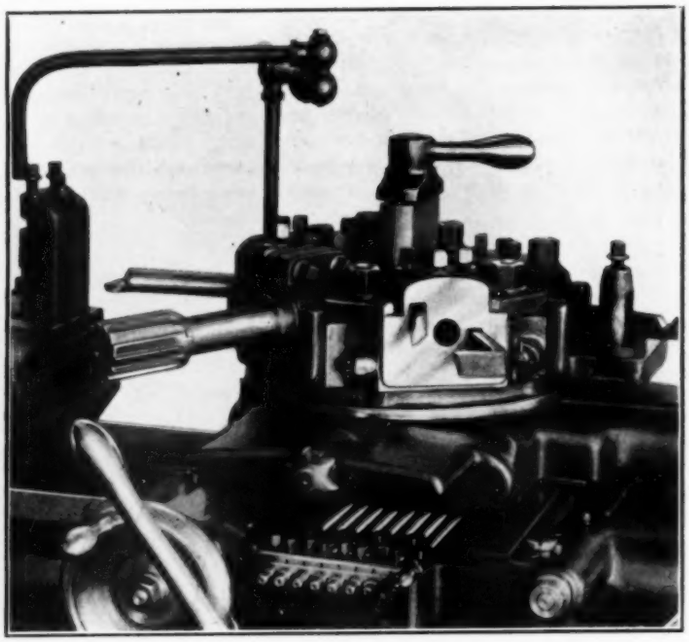

FIG. 8. TOOLS FOR CASTINGS

may then be dispensed with, and the supplementary system used in their place without disturbing adjustments.

Turret Cross Slide

The cross slide, on which the turret is mounted, and which is designed especially for facilitating the machining of large castings with ordinary lathe tools and simple boring bars, is fitted to the longitudinal slide, or carriage, in the manner clearly shown. As will be seen, a narrow dovetail guide provided with means of compensating for wear is used for retaining the cross-slide movement in correct alinement. A strap or gib is also provided, extending the full width of the slide, to overcome any tipping tendency of the latter when very long boring bars or similar tools are in use. The strains on turning, facing and other tools are downward, tending to hold the members of the compound slide firmly together and communicating the pressure to the rigidly proportioned bed.

The cross slide has both hand and power feed. The latter has six variations and may be used in either direction, an adjustable friction driving device for the feed gearing forming a safeguard against possible breakage due to accident. There are provided eight distinct adjustable cross stops, and it is possible to use these with the turret tools, in any combination desired. An adjustable micrometer ring is attached to the cross-slide hand wheel for accurately traversing the cross slide and also in quickly setting the stops in the correct relation to each other. These stops are directly in front within easy reach of the operator, and are guarded against chips. By turning any or all of the eight screws shown, the stops may be adjusted as desired. The knob at the front of the slide is utilized to bring an abutment into line with the stop that is to be used.

It is, of course, frequently necessary to bring the turret to central position, and it is important that this location should be quickly and accurately obtained. To facilitate this operation a large bronze nut rigidly secured to the cross-slide base, and through which the screw is fitted, is faced smooth at the end; in moving the turret to central position the cross-feed screw is turned until this nut is brought against

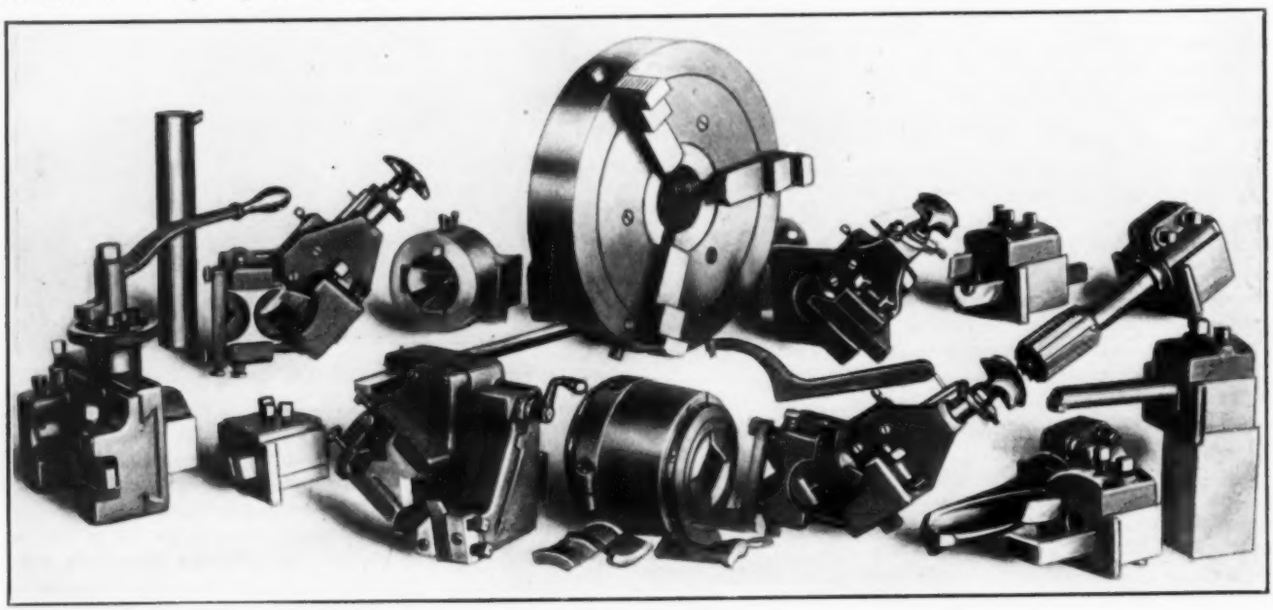

FIG. 9. A GROUP OF TOOLS

a positive stop plug firmly secured against endwise movement in the bottom slide.

Turret Tools

The form of the turret is clearly represented in Figs. 1 and 6; Figs. 7 and 8, however, show it on a larger scale, with the tools in place, the former illustrating a set of tools for operating on bar stock and the latter a part of the equipment for machining castings. In both instances the method of locating and clamping the tool holders in place is brought out distinctly. Fig. 9 also shows a group of tool holders and cutting tools, chucks, etc. As will be seen, the holders are formed with rectangular bodies which fit into the pockets in the turret, and the upper edges of which receive the triangular-shaped clamps which secure them in their seats. Several tools for machining bar material will be noticed near the center of the group, including open-side and universal turners with positive stops on their operating handles, a taper turner and a pointing tool, all of which are of much the same construction aside from the part which fits the turret as the corresponding tools for the 3x36-inch turret lathe of the same company, illustrated at page 794, Vol. 28, Part 2. These turners as shown are fitted with V back rests; in certain other turners used on this machine, roller rests are applied. The tool at the extreme left of the group is for forming and cutting off pieces, and like the other appliances mentioned is fitted with adjustable stops conveniently arranged on the operating shank.

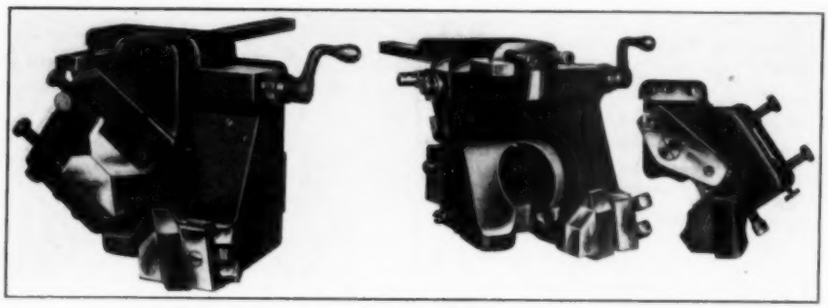

FIG. 10. TAPER TURNER

Taper Turner

The construction of the taper turner will be understood from Fig. 10. The tool slide in this device is fitted with a guide block, which is held in contact with the rear edge of the taper bar by spring pressure and the action of the cutting tool, the bar being finished to one-half the taper required on the work. When operating on bright stock, the back-rest jaws are set ahead of the cutting edge and the slide in which they are held is clamped to prevent movement. In turning tapers on rough material, forgings, etc., the back-rest jaws follow the cutting tool, and as the turret travels forward the jaws are moved outward radially, to suit the increasing diameter of the work, by means of a lever which communicates motion from the tool slide to the slide carrying the jaws. The operating lever or arm is shown clearly in the right-hand view in Fig. 10. As there indicated, it is pivoted on the inner face of the back-rest slide and its upper end carries a square shoe adapted to fit a guide formed in the tool slide, while the lower end carries a block engaging in a slot in the back-rest slide. When the turner is to be used with stationary back rest, the connecting lever is removed.

Immediately under the cutter tool and operating in a seat formed in the body of the holder is a roll which acts as an anti-

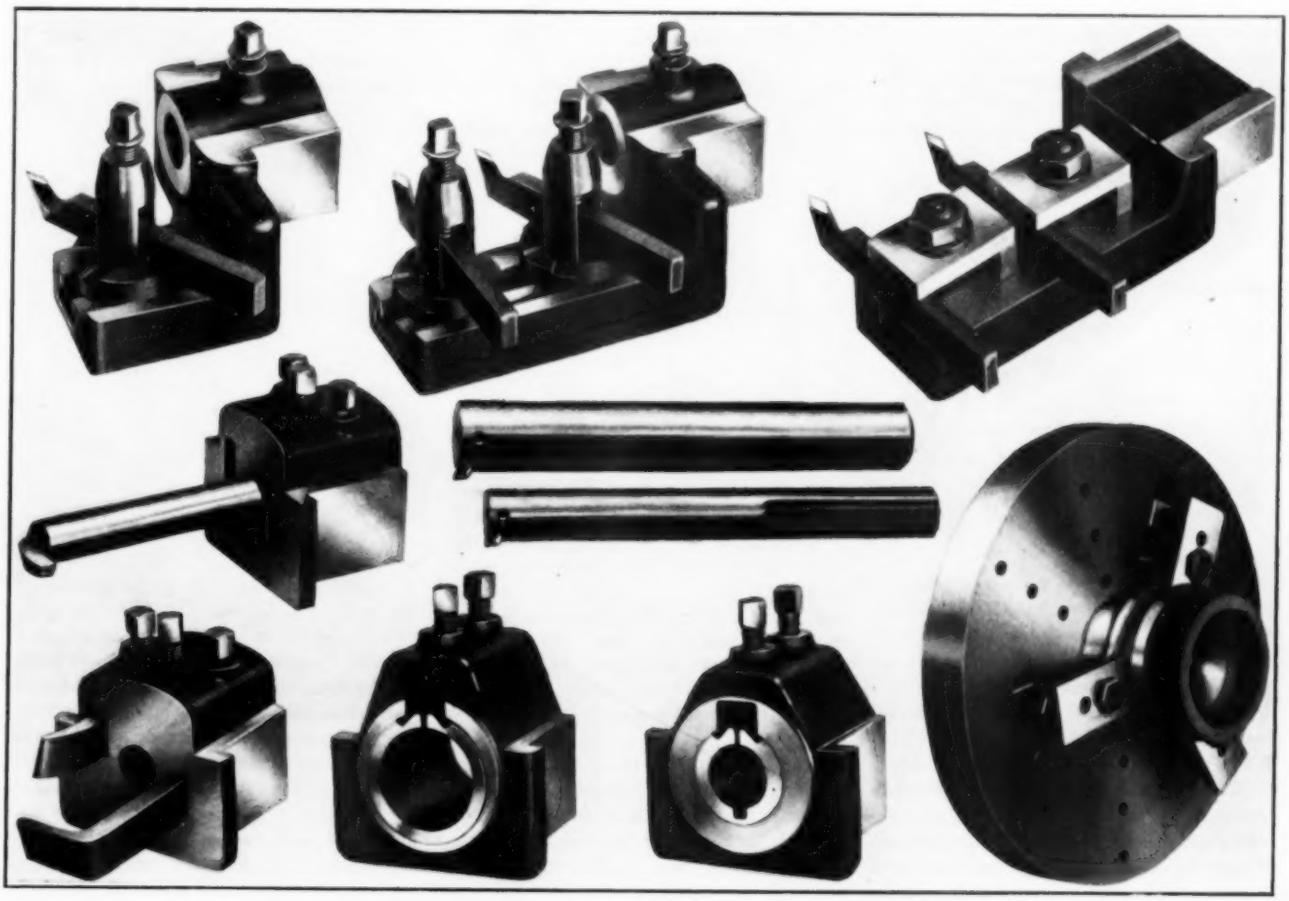

FIG. 11. TOOLS FOR MACHINING CASTINGS AND FORGINGS

friction device to allow the tool slide to move freely and without cramping during the taper-turning operation. Roughing and finishing cuts may be taken when the rests are arranged to follow the tool, by simply turning the crank handle at the front. A micrometer ring is secured to the screw which adjusts the position of the taper bar, and this enables the turner to be set accurately for producing the diameter required. The back-rest jaws have independent adjustments as shown.

Tools for Castings, Forgings, etc.

A few tools designed for use in chucking operations will be noticed in the group in Fig. 9, and Fig. 11 illustrates others along the same line. As will be observed, the majority of the holders represented in these two half-tones are arranged to receive ordinary turning, boring, facing and other tools, some of these being held in regular tool posts which may be adjusted as desired along the slotted bodies of the holders. The triple tool holder at the left and bottom of the illustration is adapted to facing and groove-cutting operations; with a boring bar in place, and by utilizing the cross feed of the turret it is suited for boring and recessing holes of wide variations in diameters. The end of the boring-tool shank is formed in the manner indicated by the smaller of the two bars at the center of the group. This ingenious method of providing the flat with a clearance groove at either side prevents any possibility of the shank swelling in the holder under the pressure of the clamping screw. Another interesting scheme is the clamping device, which is used in the tool holders shown directly beneath the boring tools, the arrangement of which will be obvious at a glance.

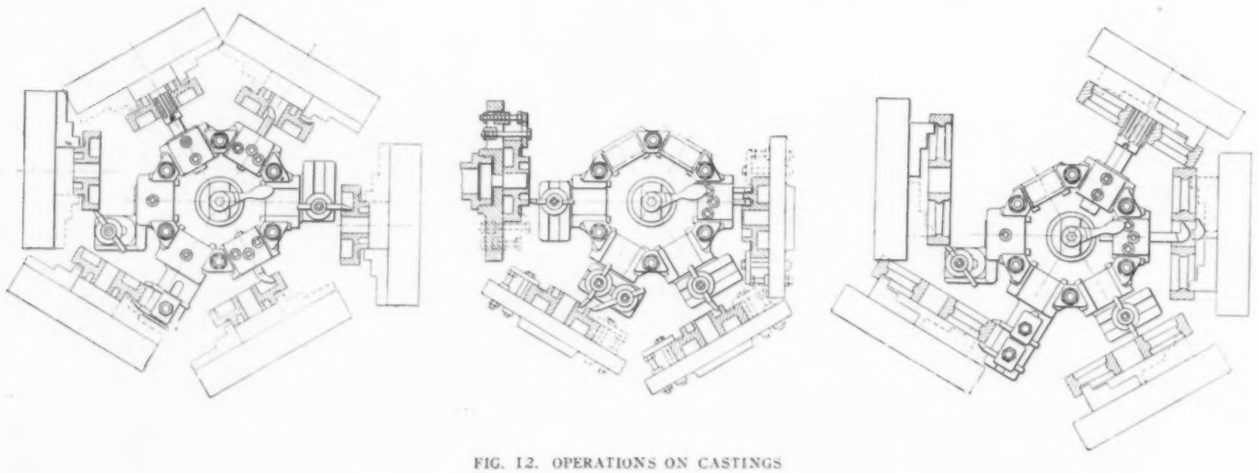

FIG. 12. OPERATIONS ON CASTINGS

The face plate with clamping equipment represented in the lower right-hand corner of the engraving is used for holding such work as cylinders, gear blanks, pulleys, etc., for the second operation, a locating plug being utilized in the manner indicated. The clamping screws and jack screws are tapped into nuts which fit the radial slots in the face plate, so that adjustments are readily made for work of various diameters. In connection with these tools Fig. 12 is of interest, as illustrating the manner in which work is held for first and second operations and the different tools brought into service for taking their respective cuts.

Step Chuck and Closer

Fig. 13 is a sectional drawing of a special chuck used when performing second operations on certain pieces which have been partially machined in the three-jaw chuck.

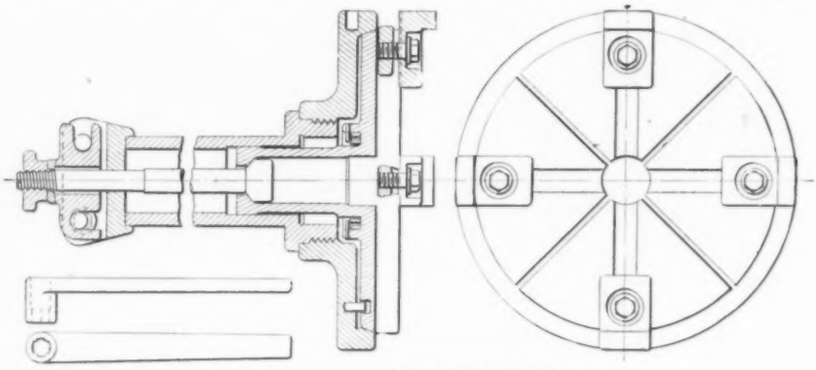

FIG. 13. STEP CHUCK AND CLOSER

The closer of this chuck is screwed tight on the end of the spindle. The step chuck is of steel, split in four places, and in each section is a dovetail slot. A nut beveled to conform to the slot is drawn up against the sides of the latter when the jaw is tightened; this gives the jaw a very tight grip. In preparing the chuck for the work, after the jaws are fastened at approximately the right distance from the center, a plug of the same diameter as the hole is inserted therein; then the step chuck is closed by the mechanism at the rear of the spindle, which consists of an eccentric operated with a wrench; the boring tool is brought forward by the turret and the jaws are turned out to the desired diameter, that is, to the diameter of the finished end of the piece made in the three-jaw chuck when the first operation was performed. The closing mechanism is then released and the plug removed. The piece of work may then be placed in the jaws, and when the chuck is closed the piece will run true. The jaws are made of machine steel, and after being used up they are easily replaced with soft-steel pieces of any shape desired. The

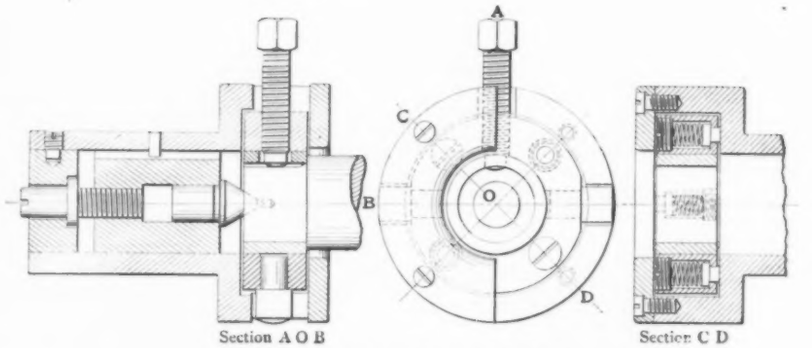

FIG. 14. FLOATING REAMER HOLDER

maximum capacity of the chuck is 12 inches.

Floating Reamer Holder

The floating-reamer holder in Fig. 14 will be seen to have some interesting features. The collar in which the shank of the reamer is secured is a free fit in the chamber formed in the front of the holder, and two pairs of spring plugs, placed as indicated in the section to the right, tend in connection with the center at the rear to hold the collar in mid position; yet the reamer is allowed sufficient freedom to adjust itself readily to the hole being reamed. The drive is by the square-head pins at opposite sides, which pass through slots in the head of the holder. The center at the rear of the reamer shank is adjustable longitudinally as represented.

Forming Slide, etc.

Where required, a special cross slide is fitted to the machine for use in heavy forming operations. This slide has both cross and longitudinal movements by hand; when the turret is being used close to the spindle, it may be moved directly under the spindle nose and out of the way of the turret. The swing over this slide is 10 inches, the swing over the bed itself being 19 inches. A geared pump delivers oil through flexible tubing directly over the cutting tools carried by the turret and cross slide, and the turret is also arranged for supplying lubricant through the interior of drills, couterbores, etc. The turret lathe weighs, with countershaft, 5200 pounds.

Poetic Anticipation

It is a well-known phenomenon that poets often anticipate inventions, but do not actually bring them into existence. With regard to the recent Brennan gyroscopic railway, still very much in embryo, it is noted that W. D. Howells, in his "Through the Eye of the Needle," Chapter V of Part Second, has the following descriptive of the railroads in Altruria: "There are swift little one-rail electric expresses running daily from one capital to another. The old steam roads of the capitalistic epoch have been disused for generations, and their beds are now the country roads, which are everywhere kept in beautiful repair." Which shows that Mr. Howells, in addition to his other titles to fame, must now be given that of prophet, for his anticipation of such a striking and original invention. But an "interference" would not do him much good.—*Electrical World.*

On account of the high price of copper, the pin-makers of Birmingham, England, are now making preparations to manufacture a large proportion of their pins of steel instead of brass.

Flow of Water through a Small Orifice

By H. W. Mansfield

I had occasion some time ago to calculate an orifice to measure the flow of water, the results of which were interesting. It was desired to deliver some 1800 pounds of water per hour at a very uniform rate, in order to have a certain degree of saturation of the steam used in testing a steam turbine. A pump had been tried and was unsatisfactory, as it was impossible to deliver the water uniformly or tell how much was flowing.

An orifice was made, a drilled hole one-eighth inch in diameter, in a disk of phosphor bronze about one-eighth of an inch thick. This was inserted as a perforated gasket at *C*, Fig. 1, in the supply pipe. Two carefully calibrated steam gages were connected on either side as shown, and outside of these were two ordinary globe valves. City water was then connected and run into a weighing tank in order to calibrate the orifice. The valve *E* was open enough to allow gage *D* to register 20 pounds pressure, as this was a convenient amount, while the other valve *A* was varied to register the desired pressure on the gage *B;* the difference in pressure between the two was the important requirement. The results of the test are given by the curve, Fig. 2.

Each point was taken several times to see that the results would check. After the curve was plotted, when it was desired to run a certain amount of water per hour, the pressure necessary would be found from the curve and held during the test. The valve *E* was changed so as to have gage *D* register 20 pounds. It was quite easy to do this, as the city water pressure was very steady; but when there was a change it came very suddenly and affected both gages at once. The valve *A* would then be turned to raise or lower the pressure on gage *B*, which would automatically bring gage *D* back to its normal reading.

The quantity of water which would flow if there were no losses due to friction, etc., was calculated from the usual formula. For an initial pressure of 125 pounds the discharge with a coefficient of unity would be 2390 pounds per hour. The quantity flowing under these conditions was 1775 pounds, showing an actual coefficient of discharge of 74.4 per cent.

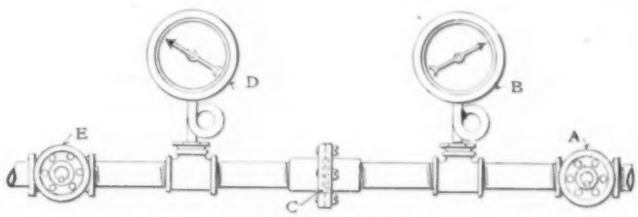

FIG. 1. ARRANGEMENT OF PIPING AND GAGES

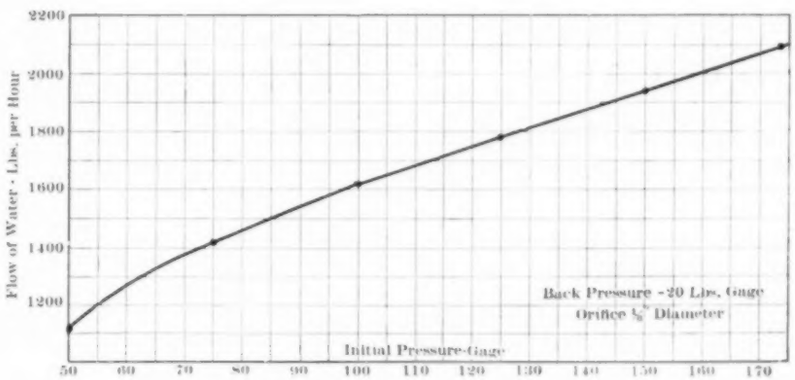

FIG. 2. DIAGRAM OF FLOW

Electrolytic Coating vs. Dipping

Der Metallarbeiter has stirred up a very interesting discussion as to the relative merits and demerits of iron that is zinc-coated by dipping and that which is electrolytically galvanized. The chief point made for the electric method is that the coating is applied at practically the temperature of normal use, while with dipping, if it is well done, the iron must reach the heat of the zinc bath. The difference in the coefficients of expansion of the two metals produces a stress in the zinc that is likely to cause flaking. The other side replies that if iron is properly dip-galvanized a true alloy of iron and zinc is formed at the point of joining, thus giving a firmer integration and adhesion than can possibly be obtained with the superficial electrolytic coating.—*The Metal Industry.*

The Effect of Ageing on Mild Steel

How Ageing Changes the Strength and Character of Mild Steel—Usually to Its Detriment—and Tests to Determine the Facts

BY C. E. STROMEYER

When, in 1885, I experimented on the effect which was produced in steel by working it at a blue heat, it was expected that this wrong treatment in the workshops would explain many mysterious failures, but I soon went through an experience which left no doubt but that brittleness could be produced by other causes. In 1889, while engaged in testing steel at some German works, I wished to experiment on some basic steel, and, not without some trouble, the manager finally consented to roll a plate out of one of their basic bessemer ingots. Two strips were at once sheared from this plate; one was bent cold, and the other after tempering. The results were satisfactory, being in agreement with those for the other steels with which I was then dealing. The plate was therefore duly marked off and sheared into strips, and a few days later a series of tests was commenced. They were to have demonstrated whether or not the quality was uniform and trustworthy under punching, bending, and other tests. To my surprise the earlier results were reversed, and all the samples proved to be brittle, no matter from what part of the plate they were taken, or rather, each strip now seemed to contain brittle zones extending about ½ inch from the sheared edges. The centers of the test pieces, being still tough, bent fairly well. Further samples which were tested six weeks later were quite brittle.

The idea that steel might go through an ageing process was scouted by all to whom I mentioned it, but experiences accumulated which strengthened my belief in this possibility. Among these I may mention that a boilermaker bought an old boiler which he had built years ago, and of which he knew for certain that the furnaces were of Lowmoor iron. He hoped that this material, which was still in request, might come in useful for repair jobs, but, very much to his disappointment, this iron had lost its excellent qualities; it was not exactly brittle, but tended toward red shortness and cold shortness. This result is confirmed by a sample taken from an iron boiler 51 years old. The material was known to be good when put into the boiler. On testing it when the boiler was cut up, the following results were obtained:

Tenacity, 18.15 tons;

Elongation, 3.1 per cent. in 8 inches.

This change might have been brought about by contact with the furnace gases, more particularly by the sulphurous fumes. Therefore, on again visiting some steel works, I tied together about half a dozen sets of samples, including both the mildest and hardest qualities of boiler steel, and exposed them to hot gases. One parcel was suspended inside a boiler, two others in various parts of boiler flues, two in the flues of a puddling furnace—one was exposed to the atmosphere, and one was tested at once by alternate bending. The others were tested in the same way, but about two months later. However, there was no marked deterioration in any one lot. Time, therefore, and not noxious gases seemed to be the determining factor.

About this time several old wooden armorclads were being dismantled in the Victoria docks, and much to my surprise the iron armor plates were being broken up like cast iron, or rather like stone flags under a falling weight. Judging by the severity of the original Admiralty tests on iron armor plates, one could not help feeling that here, too, an ageing effect had taken place.

My attention was also drawn to the tendency of solid drawn brass tubes to grow brittle and split lengthways; and recently C. Deigel* has also drawn attention to this defect, but without suggesting a cause, though this is generally believed to be an insufficient reduction in the drawing process.

The very opposite effects have also been noticed. Manganese steel, like pitch, lowers its elastic limit after straining, helical springs sometimes lose their elasticity, and galvanized steel wire sometimes loses part of its tenacity. According to Sheffield steelmakers, whose traditions reach back a few generations, steel improves by keeping, even as regards forging qualities, while spring and instrument makers prefer to use steel which has been stocked for a long time. No reason has been assigned for these beneficial changes; but there seems to be a possibility of a difference of behavior between steel which has been allowed to cool before reheating and rolling, and another lot which has been placed in a soaking pit and has never entirely lost its casting heat. The molecular changes which take place during cooling and reheating may certainly be expected to differ from those which take place during a single long-continued heat. Now, when speaking of the ageing of a material, one may imagine that either an improvement or a deterioration is taking place; but much will depend on the point of view from which this statement is made. When thinking of structures or machinery, any tendency of a material to grow brittle would be classed as deterioration, and loss of elasticity or increased plasticity would, within limits, be deemed an improvement. On the other hand, when thinking of an elastic spring, loss of elasticity and a tendency to become plastic would be looked upon as deterioration. It may therefore be as well to view the changes which can be effected by time merely as an ageing process, without seriously qualifying its relation to the various purposes to which the material might be applied.

Related Phenomena

Then, several phenomena which occur in physics and in chemistry will appear to throw some light on this subject. It is, for instance, well known that sulphur can be made elastic by pouring it into water, and, according to a recent experiment, it can even be converted into a fluid substance by pouring it when molten, into an intensely cold liquid. Both forms of sulphur, however, become brittle if left to themselves. Possibly, but this has not been established, brittleness has to be initiated either by the introduction of a crystal, or by application of a stress, like the application of a shearing stress to the edges of the steel plates, as mentioned above.

Another related phenomenon is crystallization of supersaturated solutions of salts, notably sulphate of soda. The solution is a perfectly homogeneous one, but on introducing a crystal, and thereby relieving or initiating a strain in the fluid, sudden segregation of part of the salt takes place. The well known sudden solidification of molten phosphorus is a similar phenomenon. The slow changes which take place in solutions of carbonate of soda are analogous to some euctectic phenomena in solid metals, and may help to an understanding of this difficult subject of ageing.

Mild Steel Not Absolutely Stable

Mild steel being now recognized as a complex solid solution of ferrite, pearlite, and other compounds, which may be adulterated with phosphorus, sulphur, etc., and are capable of undergoing slow molecular changes, should not be treated as in the past as being absolutely stable at ordinary temperatures, more especially as there can be no doubt that severe stresses produce

*Abstract of paper presented to the Iron and Steel Institute.

*Ver. d. Vereines zur Beforderung des Gewerbfleisses. Berlin, 1906, p. 177.

continuous changes of shape. Thus armor plates emit singing noises for a long time after they have been fired at, and sometimes crack spontaneously when left to themselves. Shells for guns used to crack months after they were hardened. Many flanged boiler plates have cracked while lying idle; test pieces not infrequently crack long after they have been bent. Probably the best illustration of ageing is given by mild steel which has been bent at a blue heat. At a blue heat mild steel 7/16 inch thick can be bent about two to five times through an angle of 45 degrees. With certain qualities of steel it was found that if the samples were bent through a single angle of 45 degrees and then allowed to rest, they soon became absolutely brittle and broke with a single blow of the hammer.

A Defective Boiler Plate

Shortly after the experience referred to above with a basic bessemer steel plate, my attention was drawn to a shell plate of a marine boiler, which had burst under the maker's hydraulic test of 180 pounds per square inch, though designed for a pressure of 150 pounds by the board of trade rules. I obtained a piece, as shown in Fig. 1 and marked *C C*. It was 5 feet

FIG. 1. PLATE C C

4 inches wide, including the rivet holes in the circumferential seams, 11 inches long from the longitudinal fracture to the newly sheared edge, and 1 inch thick. It was sent to John Brown & Co., Ltd., Sheffield, and rolled down to ⅜-inch thickness, and would now have a length of about 27 inches. It was cut in three, and two of these strips were each sheared into thirteen test strips, as shown in Fig. 2. The plate was turned over with each shearing, so that both sheared edges of each piece were turned either up or down. This is indicated by the dotted lines in Fig. 2. All the subsequent bending was done with the fins on the inner curvature.

The samples *H* were bent at 212 degrees Fahrenheit, with a view to ascertaining whether the material would be more brittle under steam than when cold, and the samples *F* were bent while very cold, as it had been found that, at any rate, bad steel is most brittle when cold.

Samples marked *I* were dealt with on February 19, 1891, immediately after shearing, and all bent double, though No. 1 (after freezing) cracked.

Five days later, on February 24, 1891, samples marked *II* were bent double, but No. 15 (after freezing) broke. After waiting fourteen days, on March 6, 1891, samples marked *III* were bent. No. 4 bent nearly double, and broke in two places. No. 10 broke with a slight curvature at an angle of about 20 degrees; both had been in the freezing mixture. None were bent at the ordinary temperature, and those exposed to a steam blast bent double as before.

I was not able to be present about the middle of March when the samples marked *IV* were bent—say, two months old—and instructions seemed to have been misunderstood; for Nos. 6 and 17 were evidently annealed, Nos. 11 and 24 appeared to have been steam heated, and presumably Nos. 5 and 18 were bent at the ordinary temperature, and not, as intended, after freezing. No. 5 bent double, but cracked on the inner radius; No. 18 bent nearly double, and broke nearly through both inside and out. On account of the above mentioned uncertainty, it is impossible to say whether deterioration, as compared with Nos. 2, 8, 16, 22, had taken place, or improvement, as against Nos. 4 and 10.

On July 28, 1891, I tested the last four samples, Nos. 12, 13, 23, 26. They were all first placed in the freezing mixture, and on bending all proved quite brittle.

Number	1—2	3—4	5—6	7—8	9—10	11—12	13
Down or up	*D—U*	*U—U*	*U—U*	*—U*	*D—U*	*D—U*	*D*
Date	*I—I*	*II—III*	*IV—IV*	*I—I*	*II—III*	*IV—V*	*V*
Condition	*F—C*	*H—F*	*..—A*	*F—C*	*H—F*	*..—F*	*F*
Number	14—15	16—17	18—19	20—21	22—23	24—25	26
Down or up	*D—U*	*D—U*	*D—U*	*U—U*	*D—U*	*D—U*	*D*
Date	*I—II*	*II—IV*	*IV—III*	*'—II*	*II—V*	*IV—III*	*V*
Condition	*H—F*	*C—A*	*..—H*	*H—F*	*C—F*	*..—H*	*F*

D = bent down.
U = bent up.
C = bent at ordinary cold temperatures.
H = bent at about 212 degrees F., after exposure to a steam blast.
F = bent after being cooled down to about 10 degrees F. in a freezing mixture of salt and ice.

FIG. 2. PLATE *C C* ROLLED DOWN TO ⅜-INCH THICKNESS AND CUT UP.

No. 26 (bent down) behaved best, bending to an inner radius of about ⅜ inch before cracking. No. 13 (bent down) bent to more than a right angle, with a radius of ¾ inch, and broke short. No. 23 (bent up) bent to a little less than a right angle, with a radius of ¾ inch, and also broke short, and No. 12 (bent up) broke off short after bending through an angle of only 20 degrees. Irregularities in the results are attributable to the difficulty of getting equal cold temperatures.

These results could leave no doubt but that the material did deteriorate at ordinary temperatures, but the effect could be made apparent only if the samples were made very cold before bending. Recently this ageing effect has been confirmed on the projecting ends of Nos. 2, 8, 16, and 22, which have now been bent—*i.e.*, after sixteen years' waiting—at ordinary temperatures. In each case the samples cracked at both edges when the bending amounted to a right angle, and the inner radius was about ⅜ inch. However, the two annealed samples, Nos. 6 and 17, have bent double, showing that the brittleness has to be started by such severe straining as occurs with shearing. This steel appears to have been made by the acid bessemer process, and several other boilers made from the same material gave trouble in practice and had to be replaced.

A Series of Test Plates

The difficulty of demonstrating the ageing effect, except either by freezing the samples or by waiting several years, even although the material, after passing the surveyor's test, deteriorated so much as to burst at an hydraulic test pressure of about 25 per cent. excess over the working pressure, decided me to postpone any further researches until I had collected other samples which had given trouble in practice. These I proposed to compare with steel from recognized first-class steelmakers, both British and foreign, and I have gradually collected the plates enumerated in Table 1. The date of receipt is stated, as there are indications that the older samples have improved.

The desirability of commencing the tests made itself felt in 1904-1906, when the specimens *U* and *Q* were received, and *R*, *S*, and another plate, No. 9, cracked in the boiler works. The difficulty, however, which had hindered inquiry in the past had not been removed, and no test had yet been devised which would reveal that brittleness in plates which seemed to cause them to fail when riveted up, but did not show itself in the ordinary testing. Over and over again tensile and cold and temper-bending tests have given satisfactory results with plates which have failed as structures. It was therefore desirable, if possible, to try to find a discriminating test, and it was finally decided to carry out as many tests as possible, and to establish a co-relation, if that existed. But as the feeling was already a strong one, that shearing stresses could produce an ageing effect, a case, No. 9, similar to *S*, which occurred in 1905, was first dealt with as follows:

Narrow test pieces were sawed out of the plate, the first being close to the sheared edge, and these were tested for elastic limit, tenacity, and elongation. The results showed that there is practically no difference between the samples taken from near the edge, and those farther away from it. Yet there could be no doubt but that the material had been injured by shearing, for not only did the strips which were sheared off in the boiler shop prove to be brittle, but other strips sheared off at the steel works after

the plate was returned were also brittle. All these strips had one old and one new sheared edge. Other strips taken from farther in the plate, with both edges newly sheared, behaved excellently. Evidently the shearing stress had not yet had time to create brittleness. The other plates from the same charge behaved equally well, although the test strips had old sheared edges. The analysis was also good. The only cause which can be suggested for the brittleness which in the one plate gradually extended from the sheared edges, was that possibly this one cogged slab had remained for two heats in the reheating furnace, but absolutely no confirmation of this view could be obtained.

This experience confirmed previous ones, that tensile tests are not as good as bending tests for detecting brittleness. But bending tests of samples with sheared edges are also not satisfactory, for so very much depends on the condition of the shears. For this reason all the samples of the experiments, *A* to *Z* and *B B*, were sheared at one time; but even now one could see that different edges were obtained, according to the manner in which the men held the plates; and although the shearing blades were new when starting, they soon got roughened and chipped, so that one cannot feel sure that the shearing effect is the same either in all samples or in different lengths of the same sample. Bending tests with sheared edges were, however, decided on, as well as alternate bends of samples having sheared edges. This method was first adopted in my investigation on the "Working of Steel and Iron at a Blue Heat."* The test has been considerably improved on this occasion. Each test piece has now had a hole punched into one of its ends, and this is fitted over a projecting stud of the anvil block, whose one face has a slant of 45 degrees. By this means one can insure that the bending would always take place at one point.

Neither of these tests, nor the tensile test, can be considered as being capable of revealing local brittleness, for before the sample ruptures it will have been subjected to enormous deformations. Thus in tensile test pieces, a not unusual contraction of area of 50 per cent. is of necessity associated with a local elongation of 100 per cent., and any local hardness would, most probably, be kneaded into a thorough plastic condition before it could do harm. The same results apply to the ordinary bending test. The idea, therefore, suggested itself to localize the injury, and also to locally weaken the section, so as to start a local fracture if brittleness had been created. With this end in view, the uncertain effect of shearing set up was, in one batch of samples, entirely removed by annealing, and the samples were then nicked across their widths by a chisel, shaped as shown in Fig. 3, which projected out of the flat, and could penetrate the metal only to a certain depth. The samples were then bent, the nick being on the outer curvature. This proved to be too severe a test, more especially after the brittleness due to the nicking pressure had had time to spread. Other batches had been annealed and the sides planed flat, and were then nicked on the edge and bent. This test was found to be of a fairly discriminating nature, some samples bending double, while others bent through only a few degrees. Four tests were made on samples cut from one strip, with the following inner radii: *A*1, radius, 9/32 inch; *A*2, 5/16 inch; *A*3, 7/32 inch; *A*4, 7/32 inch. The results obtained by this test, as recorded in Table 3, are also so very consistent that I feel sure it will recommend itself, if not for general use, at least for special investigations.

U Chrome vanadium steel, ⅜ inch thick, 1906.

V North British acid open-hearth, 1906, ordinary quality, ¾ inch thick.

W North British acid open-hearth, 1906, hard quality, ¾ inch thick.

X North British basic open-hearth, 1906, dead soft quality, ¾ inch thick.

Y North British acid open-hearth, 1906, ¾ inch thick.

Z North British basic open-hearth, 1906, ordinary quality.

BB English acid open-hearth, 1907, ordinary quality, ¾ inch thick.

S English acid open-hearth, 11/16 inch thick, intended for butt straps. It broke, 1905, while test strips were being sheared at boiler works. It contained much phosphorus and strong central segregations.

A German (*I.*) basic open-hearth, 1892, very mild, ⅝ inch thick.

B German (*I.*) basic open-hearth, 1892, medium mild, ⅝ inch thick.

C German (*I.*) basic open-hearth, 1892, 30-ton steel, ⅝ inch thick.

D German (*I.*) basic open-hearth, 1892, medium mild, ⅝ inch thick. Phosphorus and sulphur above usual average.

E German (*I.*) basic open-hearth, 1892, medium mild, ⅝ inch thick. Phosphorus and sulphur above usual average.

F German (*I.*) basic open-hearth, 1892, medium mild, ⅝ inch thick. About 0.25 per cent. phosphorus and much sulphur.

G German (*I.*) acid open-hearth, 1892, ordinary quality, ⅝ inch thick.

H German (*I.*) acid bessemer, 1892, ordinary quality, ⅝ inch thick.

J German (*II.*) basic open-hearth, 1892, quality not stated, ⅝ inch thick.

K German (*II.*) basic open-hearth, 1892, quality not stated, ⅝ inch thick.

L German (*II.*) basic open-hearth, 1892, quality not stated, ⅝ inch thick.

R Boiler-shell plate, which cracked in 1903 while being bent in boilermaker's roll, before planing edges. Thickness, ⅞ inch North British acid open-hearth. Accidentally a truck load of phosphoric pig had been charged into the acid open-hearth furnace. All inspectors' tests and subsequent tests were good. Phosphorus, 0.165 per cent.

T Part of a marine boiler-shell plate, 1⅛ inches thick, which burst in London under the hydraulic test about 1890. Details of manufacture were not obtainable. Possibly similar material to *C C*.

M Butt strap of a large water suction pipe, of which duplicate burst while at work. Believed to be basic bessemer steel made in 1892, 7/16 inch thick, 4 inches wide.

N Shell plate of a boiler, which cracked longitudinally after four years' work, built 1889, failed 1893, ½ inch thick. Adjoining boilers also cracked, and all were discarded at once.

P Plate from a boiler which exploded at Rochester, U. S. A., in 1897, said to be due to an incipient crack. The plate as received had no fractured edges; thickness, ⅜ inch.

Q Plate from a boiler which burst, October 17, 1905, in Austria while being tested at the maker's works.

U Boiler-shell plate which burst, 1904, under the Russian government inspector's hydraulic test, after being in use for six years. The adjoining boiler burst in the same way in 1905.

TABLE 1

Samples Annealed, Planed on Edges, and Nicked on Edges

There are two sets of these tests (see Table 2.) The first set, Nos. 2 and 14, were respectively bent immediately after nicking, and twelve weeks later. Nos. 11 and 23 were respectively bent immediately after nicking and after boiling at 212 degrees Fahrenheit, and waiting one day. This second test was carried out at the suggestion of Dr. Ewing, his opinion, which has been thoroughly confirmed by these tests, being that any hardening process which might be going on would be very materially accelerated by this short boiling. This second lot of samples was not annealed, planed, and nicked until twelve weeks after the first lot, and unfortunately the annealing conditions were not quite the same for the two lots. This will account for discrepancies as regards the lots Nos. 2 and 11, which ought, in all cases, to be in close agreement; but it is only with *A*, which material has all along behaved rather erratically, that there is any serious difference.

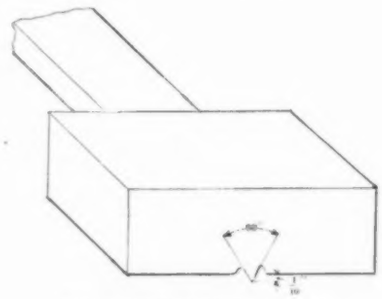

FIG. 3. THE NICKING CHISEL

Exceptionally good first tests were obtained with samples *A*, *L*, and *P*. Next in order come *P*, *E*, *G*, *J*, *S*, *T*, *U*. The worst results are *C*, *F*, *R*, *Y*. This might have been expected for these steels; but only one of the eight steels which misbehaved themselves is among the last four, so that it is evident that the single nicking test does not reveal all bad qualities.

As regards the ageing effect, it will be

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noticed, if the twelve weeks' waiting tests and those after fifteen minutes' boiling be compared, that the results with samples *A, G, H, O, P, R, X, Y* are in close agreement. Of these, both *R* and *X* have improved with age. *A, G, P* have deteriorated somewhat, and *H* and *Y* very considerably.

Rather less consistent results were obtained with the samples *B, F, J, L, N, T, U, V, W, Z*. Of these *F* only has improved; *V* and *Z* may be classed as not having changed; *L, T, U* have deteriorated somewhat, and *B, J, W* rather much. The discrepancies with regard to the remaining six samples are rather large; but even in cases *K* and *S*, and *BB*, where the effect produced by ageing is the reverse of that produced by boiling, one may safely say that there is either no effect or a deterioration. *C* and *D* have markedly improved, and *E* has distinctly deteriorated.

Deductions

These deductions and remarks about the plates are contained in Table 3.

as in this case, the phosphorus is high. The ageing effect in these samples seems to have been to improve them. In practice one would hardly expect this result, so that although the nicking test does seem to single out certain defective qualities of steel, it should not be relied upon to detect phosphoric steels, and should not be used until a more extended experience has been gained with it, at steel works and in boiler shops.

The conclusions to be drawn from these several tests are that certain steels do possess ageing qualities, that some steels tend to improve with time, others to deteriorate. That as yet the process which gives results which are most in harmony with practical experience is to plane the edges of two samples, to nick them with a specially prepared chisel, and then to bend one sample at once and the other after waiting some weeks or after boiling.

I hope, before I complete these experiments, that I may receive suggestions as to what I should do with a few odd batches of samples; but when the work is ended, I at least would be the last to suggest that 800 tests, no matter how systematically they may have been carried out, should in any sense outweigh the practical experience which engineers have gained with millions of different forms and sizes of structures. Although I am responsible for the safety of over 8000 boilers, I do not feel alarmed by the knowledge I have gained that steel and

C Improved. German basic 30-ton steel.
D Improved. German basic steel. High phosphorus.
F Improved. German basic steel. Very high phosphorus.
R Improved. North British acid steel. High phosphorus.
X Improved. North British basic steel. Dead soft.

V No change. North British acid steel. Ordinary quality.
Z No change. North British acid steel. Ordinary quality.

A Deteriorated. German basic steel. Very Mild.
E Deteriorated. German basic steel. Medium.
G Deteriorated. German acid steel. Ordinary quality.
K Deteriorated German basic steel.
L Deteriorated. German basic steel.
N Deteriorated. British steel. Boiler shell cracked; four years old.
P Deteriorated. Plate from an exploded Boiler. Rochester, U. S. A.
Q Deteriorated. Plate from a dome which burst during test. Austria.
S Deteriorated English acid steel. Broke in shears.
T Deteriorated. Marine boiler shell. Burst during test.
U Deteriorated. Russian boiler. Burst when six years old.
BB Deteriorated. English acid steel. Ordinary quality.

B Much worse. German basic steel. Medium quality.
H Much worse. German acid bessemer steel.
J Much worse. German basic steel.
W Much worse North British acid steel. Hard quality.
Y Much worse. North British acid steel.

O Grew brittle. Chrome vanadium basic steel.

TABLE 3. AGEING EFFECTS ON SAMPLES WHOSE PLANED EDGES WERE NICKED. NOS. 2, 11, 14 AND 23. SEE TABLE 2.

No.	2.†				14.				Ageing Effect.	11.				23.†			Effect of Boiling	No.
Age when Bent.	0.				12 Weeks.				0.					Boiled and Bent Next Day.				Age when Bent.
Plate.	Bent.‡	Inner Radius. Inch.	Outside Stretch. Per Cent.	Fracture. *	Bent.‡	Inner Radius. Inch.	Outside Stretch. Per Cent.	Fracture. *	Nos. 14. Nos. 2.	Bent.‡	Inner Radius. Inch.	Outside Stretch. Per Cent.	Fracture. *	Bent.‡	Inner Radius. Inch.	Outside Stretch. Per Cent.	Fracture. *	Nos. 23. Nos. 11.	Plate.
O	*u*	3/32	38	S.	*d*	Broke.	0	C.	0	*d*	11/32	34	S.	*d*	Broke.	0	C.	0	*O*
V	*u*	5/32	43	S.	*u*	3/16	36	S.	0.83	*d*	1/8	27	S.	*d*	1/16	31	S.	1.14	*V*
W	*u*	3/32	49	S.	*u*	3/16	16	S.	0.33	*d*	3/16	27	S.	*d*	1/16	16	S.	0.59	*W*
X	*u*	11/32	38	S.	*u*	1/16	51	S.	1.34	*d*	3/16	27	S.	*d*	0	43	S.	1.59	*X*
Y	*u*	3/16	27	S.	*u*	1/8	16	S.	0.59	*d*	3/16	27	S.	*d*	1/16	16	S.	0.59	*Y*
Z	*u*	1/8	31	S.	*u*	3/16	27	S.	0.87	*d*	3/32	43	S.	*d*	0	49	S.	1.14	*Z*
BB	*u*	1/16	38	S.	*u*	1/8	16	S.	0.42	*d*	1/16	36	S.	*d*	1/32	38	S.	1.10	*BB*
S	*u*	11/32	49	S.	*d*	1/8	51	S.	1.04	*d*	3/32	43	S.	*d*	1/16	16	C.	0.37	*S*
A	*u*	Close	68	S.	*u*	1/16	51	S.	0.75	*u*	1/16	31	C.	*d*	1/16	16	C.	0.52	*A*
B	*u*	1/16	51	S.	*u*	1/8	16	S.	0.31	*u*	1/16	51	S. br.	*u*	1/16	27	C.S.	0.53	*B*
C	*u*	1/8	12	C.S.	*u*	1/16	16	C.S.	1 33	*u*	1.2	6	C.	*u*	1/16	16	C.S.	2.66	*C*
D	*u*	1/8	27	C.S.§	*u*	1/16	51	C.S.	1.84	*u*	1/16	36	S.	*u*	1/32	43	S.	1.19	*D*
E	*u*	3/32	53	S.	*d*	1/32	49	S.	0.91	*u*	1/32	43	S.	*u*	0	16	C.	0.37	*E*
F	*u*	1/8	12	C.	*u*	1/16	16	C.	1.33	*u*	1/16	16	C.S.	*u*	1/16	27	C.	1.67	*F*
G	*u*	1/32	43	S.	*u*	1/16	31	S.	0.72	*u*	1/32	43	S.	*u*	1/16	36	S.	0.83	*G*
H	*u*	1/32	49	C.S.	*u*	1/16	16	C.S.	0.33	*u*	1/16	31	C.S.	*u*	1/16	12	C.S.	0.39	*H*
J	*d*	3/32	49	S.	*d*	1/16	16	C.	0.33	*u*	1/32	49	S.	*u*	1/16	31	C.S.	0.63	*J*
K	*u*	1/8	36	C.S.	*d*	1/16	38	S.	1.05	*u*	1/32	27	S.	*u*	0	16	C.S.	0.59	*K*
L	*u*	Close	68	S.	*u*	1/16	53	S.	0.78	*d*	1/32	38	S.	*u*	1/16	16	C.	0.42	*L*
R	*u*	1	10	C.	*u*	1/16	16	S.	1.60	*d*	1/32	27	S.	*d*	0	43	S.	1.59	*R*
T	*u*	3/32	53	S.	*u*	1/16	38	S.	0.71	*d*	1/16	36	S.	*d*	1/16	16	S.	0.44	*T*
M	*d*	Close	68	S.‖	..	..	..	..	....	..	..	..	..	..	..	..	..	....	*M*
N	*u*	3/16	36	C.	*u*	1/16	31	C.S.	0.86	*d*	1/32	27	S.	*d*	1/16	27	S.	1.00	*N*
P	*d*	Close†	68	S.	*u*	1/16	55	S.	0.81	*d*	Close	68	S.	*d*	1/16	55†	S.	0.67	*P*
Q	*d*	1/16	51	C.S.	*d*	1/16	27	C.	0.53	*u*	..	..	..	..	..	..	..	....	*Q*
U	*d*	3/32	53	S.	*d*	1/32	43	C.S.	0.81	*d*	11/32	38	S.	*u*	1/16	16	C.	0.42	*U*

* S. = Silky fracture. C. = Crystalline fracture. C.S. = Crystalline fracture near nick, silky beyond, especially on outer edge.
† P_{20} substituted for P_{14}. ‡ Bent up or down: *u*, *d*. § These samples may have got hardened while lying on the mill floor.

TABLE 2. SAMPLES ANNEALED, PLANED ON EDGE, NICKED ON EDGE, AND BENT.

iron have ageing tendencies; for cases are brought to my notice every year in which structures have been loaded far beyond the customary limits and yet have shown no signs of giving way. These are experiences which it is difficult to explain, except on the supposition that some materials improve with age; but they naturally raise the question as to whether one cannot perceive that all materials should be of this nature, in which case many customary high factors of safety might be considerably reduced. The value, in my opinion, of the results obtained in these experiments is that they direct attention to a subject which, if followed up, may lead to an improvement of the ageing properties of steel.

Workability of Steel—A Suggestion

By A. L. Pratt

I have read with much interest the article beginning on page 874, written by T. J. Fay, entitled "Special Auto Steel." In treating more particularly of alloy steels, Mr. Fay uses an expression, "true coefficient of hardness," for a certain quality of steel. This quality he defines in another part of the article as "difficulty to machine," and in this sense I am using the word workability.

New conditions, new processes and arts often bring words into our vocabulary or alter or enlarge the meaning of existing words. I am taking advantage of this fact in using the word workability out of its strict dictionary sense, by applying it to a quality of steel which determines the relative ease or difficulty of machining, and which should be considered as one of the factors in determining its value to the user. The expression "coefficient of hardness" seems to me a little unfortunate when applied to this quality of steel. For in machine-shop usage, hardness is a quality of steel obtained by a heating and quenching process. This process, of course, would not have any connection with the qualities which we are discussing.

Mr. Fay gives an empirical equation for the determination of this quality, based upon the tensile strength, elastic limit and elongation of a test specimen of a certain section and length, this applying to what he terms "hot work." In connection with "cold work" he states that the coefficient of hardness must be really represented by the tensile strength.

The introduction and rapidly extending use of alloy and special steels for machine parts, and the difficulty of working them with ordinary shop methods and tools, bring this quality of relative ease or difficulty of machining into prominence. In many cases the increased cost of manufacture from these steels is a point to be seriously considered in determining whether or not to make a change in the raw material of a given part. Information in regard to workability is therefore of value to the manufacturer, and it seems as if expression should be given to it and a standard of comparison established. In regard to cast iron we already have a parallel. Irons are tested for hardness, or ease or difficulty of machining, by a drilling process, using a standard drill making a definite number of turns per minute and fed by a uniform force. The relation between total number of revolutions and penetrations is a measure of the workability. This is a very simple process.

In regard to steel the quality which we are considering is fixed by the chemical constituents, the method of manufacture and the method of subsequent treatment. As received from the mill, different bars with the same analysis may have different machining values. Annealing may change this quality tremendously for a given bar. Again, we have all seen bars which it seemed impossible to anneal into a condition so that they could be worked to advantage. Surely it is axiomatic to state that, all other qualities being equal, a steel which machines the easier is the more valuable to the user.

The question of determining the method of testing and of the standard for comparison which may be generally accepted may be more difficult of solution. The comparison by tensile strength or by the coefficient of hardness, as outlined by Mr. Fay, are more the methods of the investigator or the laboratory. They do not seem suited to machine-shop conditions.

As a suggestion, cannot a method be devised following the principle of the drill test used on cast iron? Cannot a comparison be made in a simple turning operation between the cutting speed and surface machining or the weight of stock removed, for different steels, and a factor of workability established? The factors of cutting speed, depth of cut, size, shape and hardness of the cutting tool and the force of the feed should be standardized and kept uniform. The production of a standard tool for this purpose would present no more difficulties than the production of standard drills for the cast-iron test, and surely the standardization of the other elements presents no difficulty whatever. Such a method properly standardized and accepted could be used in any machine shop as easily as the drill test is now used in many foundries.

Information in regard to this quality, whether obtained by such a method or in some other way, would be of value in determining uniformity of successive lots of steel received from the mill, in determining some of the advantages or disadvantages of changing the quality of steel for a given part, in aiding the piece-work superintendent to set prices on the same or similar work made from different qualities of steel, in comparing steels of the same general grade from different manufacturers and in other ways. I hope that future issues of the American Machinist may be able to furnish us with information along this line.

The Railway Engineering Course of the University of Illinois

The course of study of the new railway engineering department of the University of Illinois, as set forth in No. 8 of Vol. IV of their regular *Bulletin*, shows a very complete line of work. There are four courses of instruction: civil, electrical and mechanical engineering as applied to railways, and a course in railway administration. This course is equally as important as the first three and much more difficult in many ways, as it not only includes the corporate management, labor, accounting, cost of various service, etc., but the attitude of the railway toward shippers and the public at large.

Students have the advantages of very complete laboratories for testing and experiment, and the three steam and one electric railway in the vicinity afford ample opportunity for field work and practical demonstrations. The university owns a 200-horse-power electric test car of the interurban type, made especially for experimental work, and equipped with all instruments for testing. This is used on the lines of the Illinois Traction system when desired and affords excellent training.

Similar facilities are also extended to students in mechanical engineering with the dynamometer car, air-brake equipment and the coöperation of the Illinois Central Railroad. A booklet containing the courses of study will be sent to anyone interested in taking up such a course.

Consul J. H. Worman, of Three Rivers, reports that the price of Canadian lumber has advanced, spruce now selling at $18 to $22 per thousand feet wholesale. Logs are selling in British Columbia for $13 per thousand feet, which makes the price of rough lumber $28 to $30 per thousand feet.

The drop-frame motorcycle for ladies has made its appearance in this country. The *Bicycling World* illustrates one which is now made at St. Paul, Minn. The lower member of the frame resembles that of a drop-frame pedal bicycle and is carried around under the crank-case; above the engine is a straight frame piece from steering-head to lower end of seat post, and above that a third piece of tubing, formed in a reverse curve. The driving belt and both wheels are well covered up.

An Ordnance-building Shop in Italy

The Equipment and Work of the Pozzuoli Works, Near Naples, of the Well Known Armstrong-Whitworth Company, of England

BY J. B. VAN BRUSSELL

The Armstrong Pozzuoli Works is a subsidiary establishment of the English Armstrong-Whitworth Company and is located some seven miles west of Naples. It occupies a total area of nearly 70 acres, of which over 12 are covered by workshops, storehouses and other buildings, equipped with all the necessary appliances for the production of war material of all kinds for both military and naval uses.

The main structure in the works is a rectangular building near the center of the grounds, measuring about 460x360 feet, covering an area of about 4½ acres and containing more than 500 machine tools of different kinds. The shop is divided by lines of pillars into eight parallel bays, running east and west, with north-lighted weaving-shed or saw-tooth roofs. Each bay is given over to a special department, the arrangement being as follows, in order from north to south.

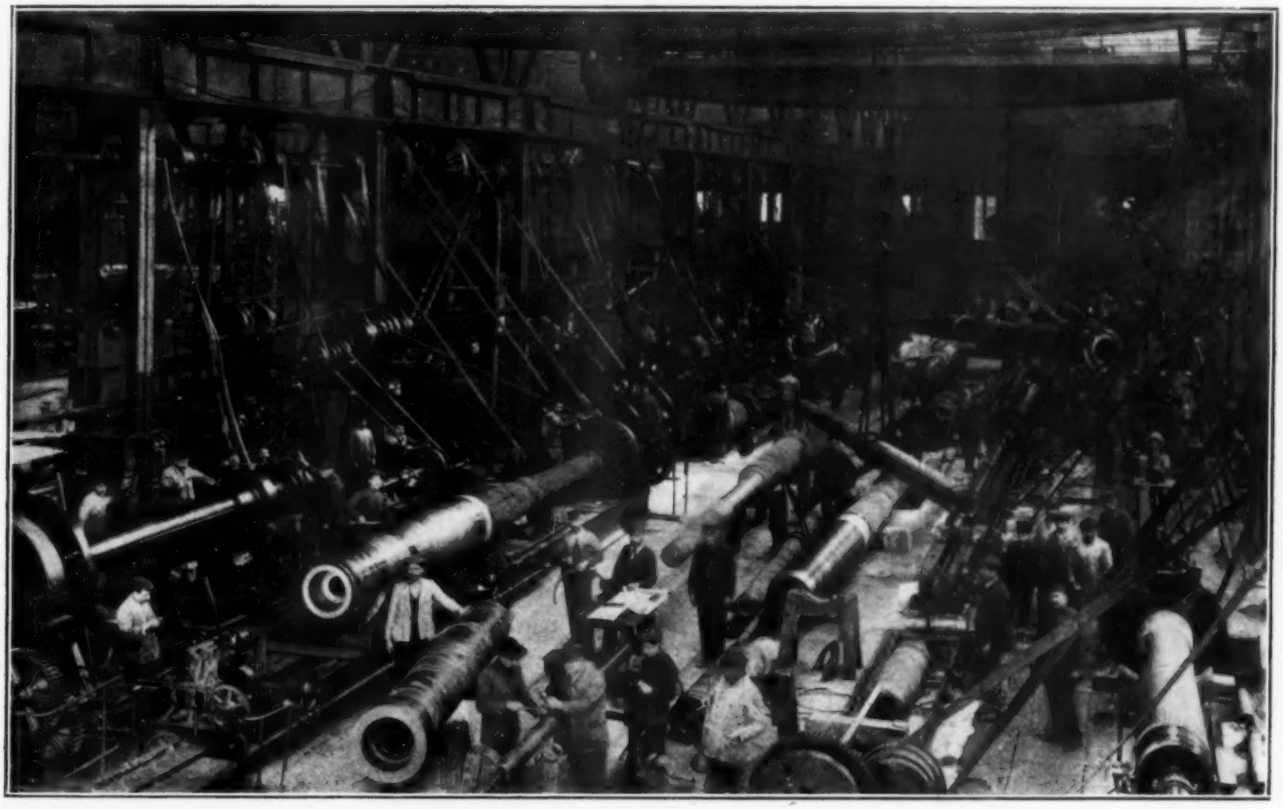


FIG. 1. BAY NO. 3. MAKING GUNS OF MEDIUM CALIBER

How the Work Is Divided

Bay No. 1 is specially equipped for the manufacture of ordnance of small calibers; No. 2 contains machinery for the production of ordnance divisions, and for this purpose it is equipped with boring and rifling lathes with beds up to 50 feet in length, which are served by two overhead traveling cranes of 70 tons each; No. 3 is for ordnance of medium calibers, the boring of the inner tubes, and hoops of the larger sizes, and for wire winding on guns of any caliber. This is shown in Fig. 1. No. 4 builds armored shields and turrets; these parts are usually completed, erected, and fitted in the works before being placed on board ship. The heavy lifting is done by a 50-ton crane, in addition to three smaller ones. Two turrets, one for 12-inch and the other for 8-inch guns, are shown under construction in Fig. 2. The same work is continued in No. 5. The sixth bay, shown in Fig. 3, in addition to containing the heavy planing machines for armor plates, is specially assigned to the construction of gun carriages and mountings, which are erected finished in No. 7. The remaining bay, No. 8, together with some projecting annexes at the west end of the main shop, contains the projectile- and fuse-making departments and the general tool room for the whole works.

Some of the Other Shops

The finishing and inspecting departments for small- and medium-caliber guns are contained in a building of about the same length as the main shop, but separated from it by the works railway. Here all the final operations connected with sights and breech actions, polishing, browning, lacquering, etc., are performed.

An adjoining shop for making DeBange obturators, or gas checks for the breeches of guns, contains a 2400-ton hydraulic press served by an intensifier working up to 15 pounds per square inch. There are also four cranes, two for eight-ton and two for two-ton loads.

The hardening and shrinking pits are placed a short distance from the heavy-gun bays on the eastern side of the main shop. They include one small and two large pits for shrinking on jacket hoops, with two hydraulic cranes for 25 and 15-ton loads, a 200-ton press, two furnaces

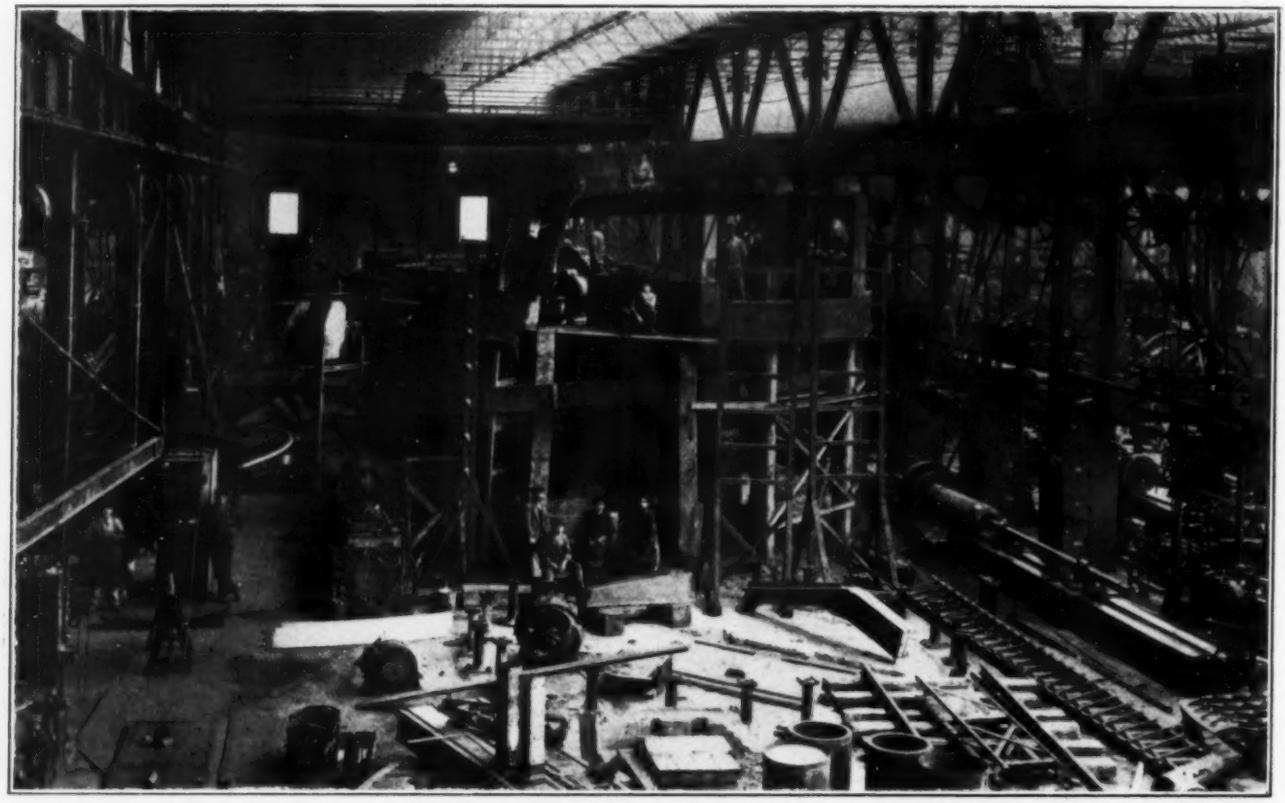


FIG. 2. BAY NO. 4. SHOWING TWO TURRETS FOR 8- AND 12-INCH GUNS

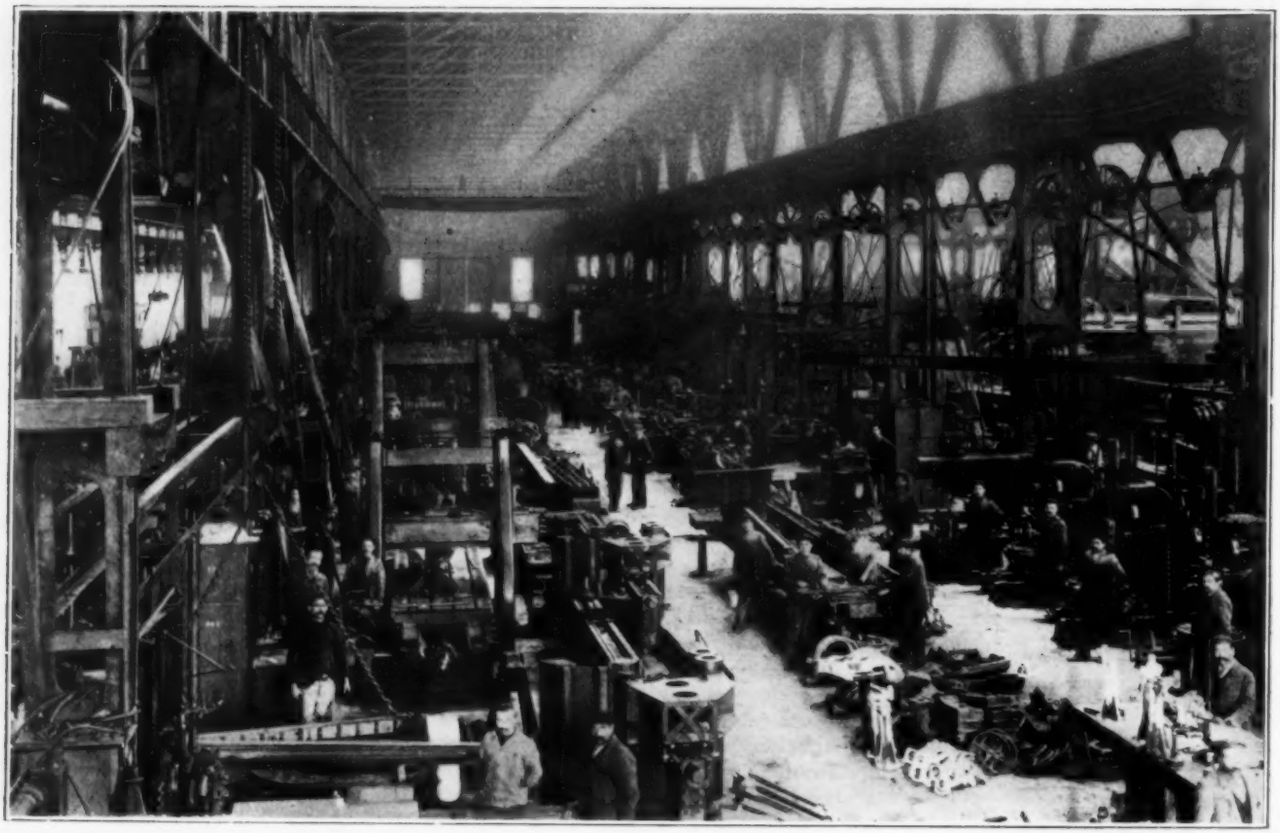


FIG. 3. BAY NO. 6. FOR CONSTRUCTION OF GUN CARRIAGES

with rotating beds for heating blooms and hoops, two special furnaces for heating hoops with Bunsen burners, and an oil hardening pit 56 feet deep.

Making Big Castings

The steel works, placed about 220 yards west of the principal shop, is a group of buildings about 650x150 feet, covering nearly three acres, and divided longitudinally into three bays. The first of these, adjacent to the railway on the north side, contains four Siemens-Martin steel furnaces on a raised platform 270 feet long, with a casting pit of the same length on the side. These furnaces, when worked in combination, are capable of producing single ingots up to 90 tons weight.

A portion of the space beyond the furnaces is used as a steel foundry. The forge shop in the middle bay contains forging presses of 800 and 4000 tons with the necessary heating furnaces, pressure pumps, and accumulators. A third bay on the south side contains the iron foundry and the crucible-steel melting shop, which has two gas melting furnaces, each taking 18 crucibles. The forging presses are served by four traveling electric cranes, two for 100-ton and two for 30-ton loads.

Proving Grounds and Docks

Beyond the works at the western end is the proving ground, occupying about 18 acres. This contains proof butts, a special mounting for guns being tested, a 10-ton traveling crane, and all the necessary buildings for shelter and chronographic observation. All the different buildings in the works are connected by a standard-gage line of railway extending over a total length of about 3½ miles. This includes the dock where turrets and guns are put on shipboard, as shown in Fig. 4.

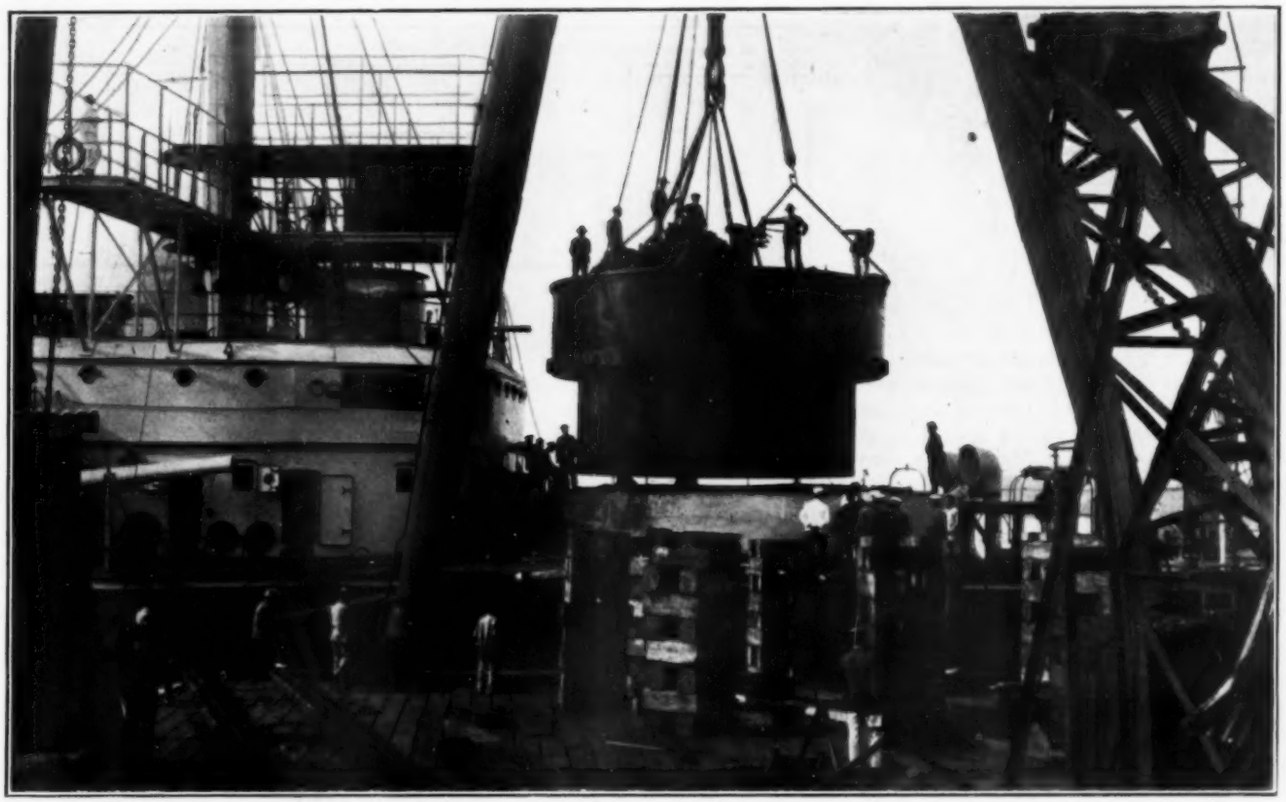


FIG. 4. PLACING A 12-INCH GUN TURRET ON ITALIAN BATTLESHIP "REGINA ELENA"

A Reply to Shop and Engine-room Notes

By Herman Fletcher

Reading "Shop and Engine-room Notes," at page 748, by C. W. Crawford, I am constrained to answer some of his statements.

The first item in order states that one of the hardest things to teach the boys in the shop is to use a heavy sledge to back out a tight key.

I have had some serious propositions in driving out keys, large and small, but have never had the opportunity to shoot one out at the first blow, as Mr. Crawford states. Again, I have found the same obstinacy among old jours, as well as in boys. It depends a good deal on what kind of key Mr. Crawford means to be driven out at one shot. If it be one that has no impediment on either end, this might possibly be done; but if it is one that is housed up firmly and well fitted in its seat and resting place, it requires a key drift, and often the getting at such a key to drive it is a conundrum.

Where a Key Should Fit

The second item, "to pound into the boys' heads the fact that a key should be fitted tightest at the point," I think, from extensive experience, to be radically wrong. If a key is to be properly fitted to hold the rotative stress, it should fit well all around; particularly, it should be a perfect driving fit in its channel, without a taper to fit the keyway, and it should have a taper of ¼ of an inch to the foot for drawing against the hub and shaft. Such keys ought to be made of tool steel and of the very best quality. Soft steel and iron are impracticable and are just as hazardous and unreliable as using a common case-hardened set-screw for fastening any piece of machinery.

Again, a hammer or a sledge is the last thing that should be resorted to in such a case; and wherever a gib key can be placed it is always advisable to do it, as it can be withdrawn easily with a pinch bar. If a boy can accurately and properly fit a key, one that will cause no trouble afterward, I think him a good worker.

Tallow and graphite is good, but as to drilling tool steel without oil, this depends entirely on the speeds at which you do the drilling.

Welding Steel without Oil

Mr. Crawford says, "When tool steel is welded there is always a film of iron between the adjacent parts." This is correct providing a film of iron is placed between the welds. But when steel and steel are welded together, no iron is

there, and this matter of placing iron between the welds was exploded long ago. There is no trouble in welding steel and steel.

The life of a hack saw depends upon the man using it. I must admit that many manufacturers make an excellent article and that the improvements made of late years have put them within reach of every mechanic and made them an indispensable adjunct to any shop. Any blade can be ruined at a single stroke by careless use.

The remark about machinists grinding their tools is not an uncommon one. You will find very few men that keep their tools in anything like proper shape; and how many men can dress their own tools at the fire? I consider that it is part of the requirements of any machinist capable of running machine tools that he should be able at least to dress his own tools and grind them to best suit his work.

The Old Diamond-point Tool

Mr. Crawford talks very discouragingly of the old diamond-point tool. If he ever used it, he certainly struck a snag. My experience has been that very few men keep their tools in proper shape and as sharp as they should be for any machine tool. I have had good men who were too careless, shiftless or lazy to sharpen up a tool to do proper work, and I am sorry to say that our good mechanics are getting less every year; I mean, an all-around man that can be trusted to do a good job in any department of a shop where he may be placed.

From reading Mr. Crawford's experiences, it seems to me that he has had a great deal to do with steamboat engineering; collapsing of pipes still occurs occasionally in distilleries, but not often, as, with vacuum valves, they have every protection.

I believe the cause of water hammer to be mostly in the defective construction of piping and the improper placing of air chambers. This important matter seems to be overlooked by the majority of steam and pipe fitters. Mr. Crawford does not give a proper cure for this defect.

In reference to packing rings, of which he speaks, I have always known them as the Stephen's packing. A great many have weak points about them, but there are a number of very reliable rings of that class which, if properly made, give excellent results. It seems to be about the only packing arrangement of the day, and every manufacturer building first-class engines of every type is using them.

The Japanese legation has sent word to the Brazilian minister of foreign affairs that there will shortly arrive in Rio de Janeiro a large liner, belonging to a Japanese shipping company which is fitted up as a floating exhibition of Japanese products, says the *Brazilian Review*.

Facing the Inside Surfaces of Two Cranks at Once

By John L. Bogert

As shown in Figs. 1 and 2, there are four cast-steel cross slides, letters *A*, *B*, *C* and *D*, each cross slide having its own separate cross-feed screw. Each cross slide carries a tool post, and "crotch" or rest tools are mounted in two of the tool posts, while the others carry double-end facing tools of high-speed tool steel. To get the best results, it is important that the distribution of rest tools and cutting tools should be as indicated, as in such an arrangement double the amount of chip resistance can be overcome. To make this more easily understood, consider the course of operation as shown.

In Fig. 1 the inside faces of crank No. 2 are shown being cut by the tool held in the tool post of cross slide *B*, and the cross thrust of this cutting tool is resisted by the rest tool held in the tool rest of cross slide *D*. Obviously there is at this time the resistance of but two cutting points to be overcome by the driving power, as crank No. 1 has its arms entirely clear of the cutting tool held by *C*.

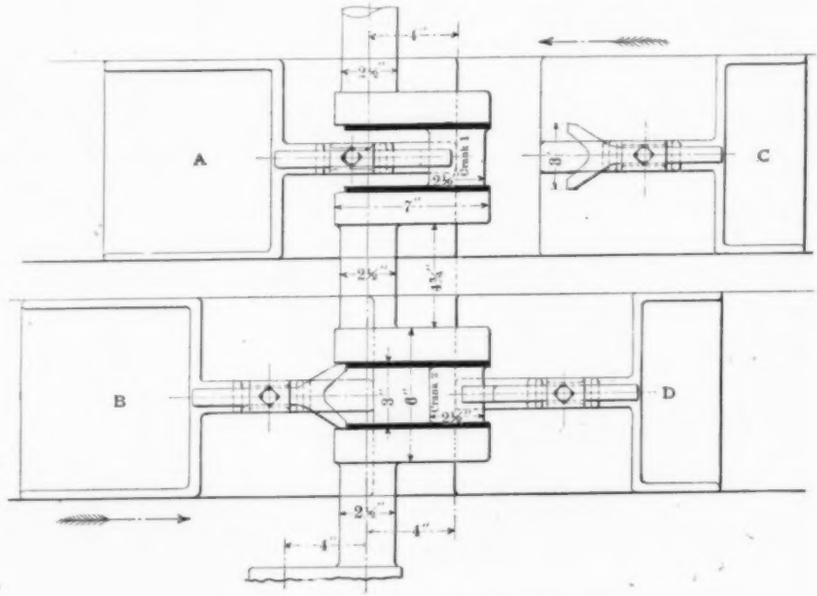


FIG. 1. PLAN VIEW OF CRANK-FACING TOOLS

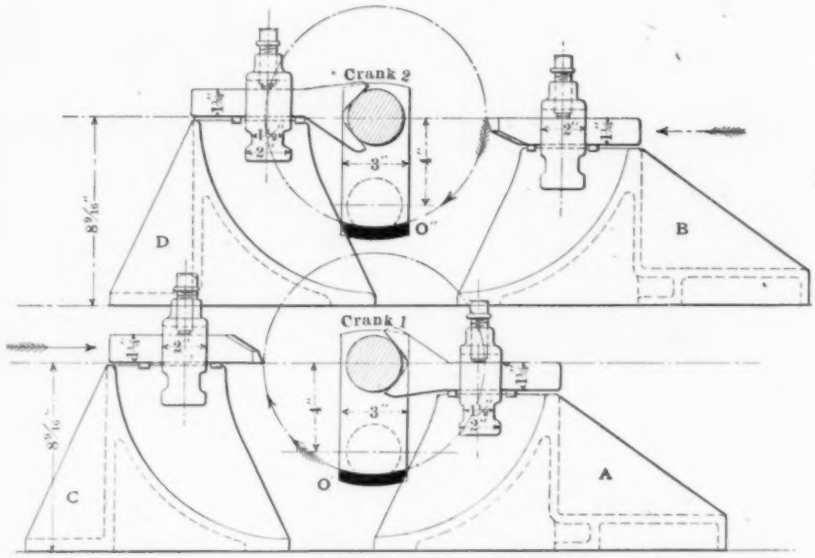


FIG. 2. SHOWING ARRANGEMENT OF TOOLS AND SUPPORTS

The rest tool held in slide *A* is the only thing touching any part of crank 1.

In the course of its rotation crank 2 passes completely away from the cutting tool of slide *B*, and in Fig. 2 is shown having turned through 90 degrees. A further movement of 90 degrees will bring crank 1 into contact with cutting tool in slide *C*, while crank 2 is rotating idly through the air. While crank 1 is having the inside surfaces of its arms cut by the

double-end cutting tool in slide *C*, it is likewise held firmly by the rest held in slide *A*. Now, because the two cutting tools are never cutting at the same time, until they have been fed down close to their respective crank-pins, the resistance to turning is but one-half what it would be if both surfacing tools were mounted on the two front or the two back cross slides. At the same time the speed of executing the work is just as rapid while requiring but half the power.

It is important to notice that by the use of the two rests facing in opposite directions it is possible to take the heaviest cuts on four-throw, six-throw or eight-throw crank-shafts of extreme flexibility. If but one carriage is used with but two cross slides, the rigidity is greatly diminished. Here is the result of the combination of tools and rests shown in Figs. 1 and 2:

The four crank-pin surfaces were cut down, as shown, in seven and a half minutes; amount of metal removed by each cutting point, 3/16 inch; speed of rotation, 33 revolutions per minute; material cut, open-hearth steel 0.35 per cent. carbon; tool steel used, German "Bischoff."

These two cranks are the inside cranks of a four-throw crank-shaft of the five-bearing or marine type, and are much more susceptible to spring and chatter than the two adjoining the chucks.

Thoughtful readers will recognize that this is but an extension of the principle that has made possible the use of the modern grinding machine. Without the use of rests it would not be possible to grind any flexible work, especially crank-shafts. The use of the ordinary steady-rest, common to all engine lathes, for crank-shaft work is an abomination, as it has to be shifted along the ways of the lathe for every pin and bearing.

Aluminum as a Protection against Mercury Poisoning

So far no satisfactory method has been known of guarding against mercury and preventing its entrance into the breathing passages, stomach and pores of the skin. In spite of the rigid maintenance of the most sanitary conditions, free ventilation and short working hours, hundreds of workmen employed in the mining, metallurgy or manufacture of mercury have died painfully from its poisonous effects.

Recently an Italian, M. Tarugi, seems to have found a method of obviating this danger by the use of aluminum. He finds in this metal a strong affinity for mercury and proposes to provide the laborers with light aluminum helmets, the breathing spaces being covered with a fine gauze made of aluminum wire. This subject is of an importance great enough to warrant careful and thorough trial of any method that offers relief from the conditions now inseparable from work in mercury.—*The Metal Industry.*

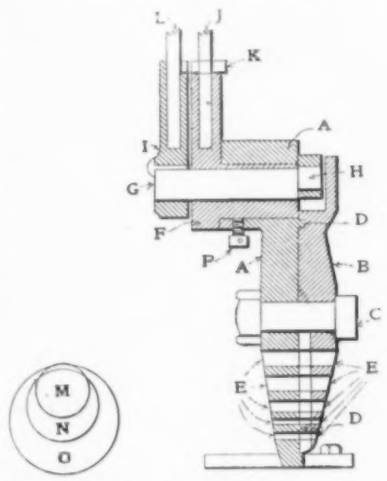
A Novel Application of Eccentrics in the Marvel Punch and Shear

The body of this machine is built in halves, the parts being held together by bolt *C*, which serves only to hold the two halves together, as the strain does not come on the bolt, but on a circular rib *D* on the inside face of *A*, and fitted into a corresponding slot on the inner face of *B*. As this gives a bearing encircling the entire machine, perfect alinement is always assured.

For shearing rounds each half has round holes *E* with a shear blade on the inner face of each, so that when they come together in shearing they make a round cut.

How the Levers Work

The inner lever socket *F* extends through top of *A* for its bearing and



NOVEL APPLICATION OF ECCENTRICS TO A SHEAR

has an eccentric opening through it. Through this opening passes a shaft *G*, which has an eccentric *H* on its end. This shaft and eccentric are fixed to the outside lever socket *I*. The inside or short lever *J* has a pin *K* extending farther on one side of the lever than the other. The top inner side of outside lever socket *I* has a half-round slot cut in. By placing the inside lever in socket *F*, with the long side of the pin toward the outside socket, the pin *K* drops into this half-round slot in socket *I* and thus locks the two together. By working the lever in this position, the motion is exactly the same as one socket and one eccentric. This is for light, quick work.

Getting a New Bite

By turning the inside lever *J* half-way around and replacing in the socket the short side of the pin *K* is presented toward the outside socket *I*, and the two sockets are thus unlocked. Placing the long lever in the outside socket *I*, both levers are thrown back from the work, the material is put in place, and the outside or long lever *L* is brought forward till horizontal. If the cut or punch is not through, the long lever is raised, *at the same time* bringing forward the short lever. This operation holds the shears or punch, as the case may be, stationary where they stopped, and gives the long lever a new bite in the material. Then the long lever is brought forward again until the cut is completed.

Use Any Stroke You Wish

This operation of raising the long lever for a new bite in cut or punch can be done with short or long strokes, as desired, the inside lever being brought forward each time the long lever is raised to take up the slack. The same action is used in shearing with either the flat or the round blades, or punching, with the exception that in punching the lever is swung toward the punch side and in shearing it is swung toward the shear side; but the action is exactly the same in both cases. *M*, *N* and *O* represent sectional views of eccentrics *H* and *F* and of the bearing in the top of half *A*. The screw friction *P* operates against socket *F* with sole leather between, and is kept screwed tight to hold this socket *F* in any position it is placed in.

The Capacity of the Machine

The machine shears up to and including ½x2 inches flat, punches ⅜-hole in ⅜-inch shears, round, up to and including ¾-inch, and makes a neat round cut. It will also shear angle iron up to and including ¼x2x2 inches in two cuts, the points of the shears in this case passing entirely through the iron at the extreme inside corner. The entire frame of the machine, parts *A*, *B*, *F* and *I*, is made of solid malleable iron. It is patented and made by the Armstrong-Blum Manufacturing Company, Chicago, Ill.

A machine, called the tesserograph, for doing away with the necessity for printing in advance the thousands of various kinds of railway tickets, is the invention of Roberto T. Piscicelli, of Florence; it also automatically registers the amounts cashed. Each ticket is printed separately by a machine from a slip of thick paper, all the necessary particulars, such as station names, date, price, class, etc., being inserted, and on a second paper strip within the machine is printed, as a check, a duplicate of the ticket sold. The money values of the tickets issued are totalized according to classes and series. A machine constructed for the Naples-Rome line can print and register 400 different kinds of tickets. The various mechanisms are interlocked together, and no tickets can be issued until the inspector in charge, upon opening the office in the early morning, has freed the machine and brought all the totals back to zero.

A Relic of Early Motor Vehicles

By Frank C. Hudson

It is not commonly known that as long as 73 years ago there was a regular interurban service in Scotland with motor-driven vehicles, but such is the case. True, the distance was not great nor the time rapid enough to endanger one to arrest by the eagle-eyed bicycle "cops" of the present day, but considering the time and scarcity of locomotives themselves, the achievement is little short of marvelous.

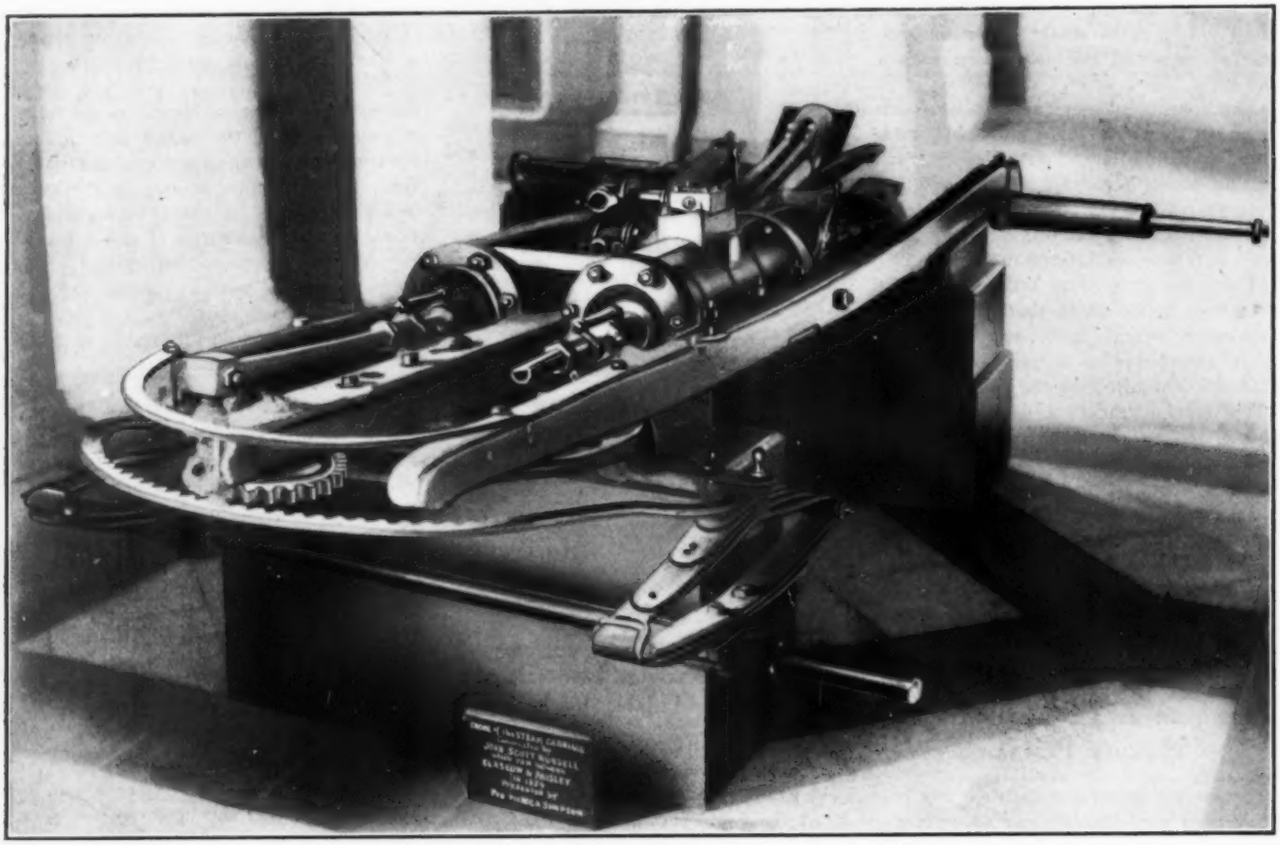
The service was inaugurated on July 2, 1834, between Glasgow and Paisley, a distance of seven miles; the time varied from a trifle under the even hour down to the record trip of 32 minutes. There is said to have been no difficulty with the vehicle itself until the last day of its operation, just 27 days after the opening of the service, when one of the wheels gave way, the whole thing turned on its side and, according to the accounts of the time, this caused the boiler to burst, killing four and injuring quite a large number. As it is customary to call every boiler accident an explosion, it may perhaps be doubtful as to just what took place aside from the fact that there was an accident that proved serious.

The designer and builder was John Scott Russell, better known in the fields of naval architecture, as he built the "Great Eastern" for Brunel, than in mechanical lines. The engine and framework are shown in the accompanying illustration, which does not look much like the modern chassis. The cylinders were about 9x21 inches, a sort of V-hook motion, and had wheels to guide the piston rod instead of guides, single eccentrics and valves without lap.

The wreck of the vehicle was laid to the obstinacy and pigheadedness of the road trustees, who objected to anything in the way of innovation and considered it their duty to wreck the enterprise. To accomplish this they had the road strewed with fresh stone to a considerable depth in places, and it is to this that smash is attributed.

The accident gave the reporters of the day an excellent opportunity to show the extent of their vocabulary, some blaming the trustees, others the designer; altogether it created such a furor that, though the wagon was repaired, not enough cared to ride to warrant its continuance.

The vehicle seated 26 passengers and, according to reports, as many as 39 were carried on a single trip, which goes to show that we of this day and generation not only fail in being the first to operate motor 'buses, but that even the crowding of cars and hanging on to straps was old before we were born.



RELIC OF A MOTOR BUS WHICH MADE REGULAR TRIPS IN 1834

Cost Accounts

By H. F. J. Porter

We frequently see the statement in print, and more frequently hear it spoken, that although the value of the principles of cost accounting has been recognized for some 25 years, still it has been only a comparatively short time since manufacturers generally have established cost-accounting systems in their plants, and thus have come to know accurately what their product is costing them. Now, while I am willing to concede the fact that cost accounting has to a very large extent become recognized as a permanent feature in the financial affairs of a great many industrial enterprises during recent years, still I know from personal experience that it does not follow as a corollary that the accurate cost of production has in every instance been attained.

But presuming for the moment that the result mentioned has actually been accomplished, I think that I am safe in stating that there is a wrong conception in the minds of many people as to what the function of a cost-accounting system really is. I have heard people who have had a system of cost accounting installed in their plant say that they were disappointed in its not accomplishing the saving that they had been led to expect would

be brought about by its introduction; and that on the contrary there had been an increase in expense by just the amount it cost to run the cost system. To my mind, and to the minds of many who have had to do with manufacturing enterprises, the aim of an efficient cost system should not be to determine simply *what a product costs*, but rather *why* it costs what it does. People nowadays are not satisfied to be informed that a condition exists, but demand to know the reason, so that if necessary it can be modified intelligently. It is intelligent action on the information presented by the cost system that accomplishes the saving, not the system itself.

This result is by no means always attained by cost systems as they are generally operated, and while there are many and diverse reasons for this condition, the foremost is the expense of installation and operation. I want to emphasize strongly the distinction which I shall make later between these two operations, viz., the installation and the subsequent operation.

First of all, it requires a competent and experienced man to design and install a suitable and comprehensive cost system. The services of such a man are in great demand and therefore expensive, and this expense together with the cost of employment of those who are subsequently to operate the system—all of whom will swell the ranks of the non-producers—deter many from making the proper investment. In fact I have heard some people say they feel perfectly able to install their own system, and resent the suggestion that an outsider should do it for them as a reflection upon their own competency.

These people do not recognize the distinction between the ability to design and install, and the more simple qualification to operate subsequently. The first is that of a recognized specialist, the latter that of a first-class bookkeeper. Very few have the former, but all concerns have the latter in their employ. The only way in which they could be considered competent would be by having on their regular staff a man of the first type, and if they were thus equipped the inference would be that they were paying continuously too much for occasional expert supervision.

There is no more need for the continuous service of such a man in an ordinary business than there would be, for instance, for an engine designer. When an engine is needed to operate a plant it is not designed and built. A firm of engine manufacturers supplies a suitable engine and installs it. The subsequent operation is a matter that is entrusted to regular mechanics. And so the now recognized profession of constructive accountancy should be similarly dealt with, if it is desired to obtain the character of a cost system which is needed in a growing business, viz., one which is adapted especially to its needs, and will be flexible enough to adapt itself to changes as they develop.

The essential features of this system of costs must conform to the general commercial accounting system of the business, so that they can merge and become one. After the system is installed, it can be handled by the staff of bookkeepers already employed, with such additions as the increased amount of work necessitates. The type of manager which every industrial enterprise should have nowadays is one who has received some technical education, and will be able to analyze the statements presented regularly by the cost system, draw his own deductions and act intelligently upon them. In other words the subsequent success of the cost system will be measured by the ability of the manager to make use of it. Those who do not have a cost specialist on their staff, if they feel as some do about securing an outsider when called upon to develop a system of cost accounting, are very apt to fall back on their own resources and put in a simple "labor and material record" account, distributing the general expense over the output according to the ratio of direct to indirect labor. This gives the cost of product, according to their notions, and they let it go at that until competition opens their eyes to the fact that there must be something wrong somewhere, then there is trouble, and generally the innocent suffer.

There are, however, many concerns who have realized the nature and value of the work of a cost specialist, and have gone to the expense of having a high-grade system installed. But it is surprising how few of even these systems remain operative at their full efficiency. This failure to secure the desired result after the lapse of time seems to be due to the lack of recognition of the human element in the office force engaged in the work. It takes a good man to keep a high-grade cost system abreast of the demands of a growing business. Good men are always in demand, and a day arrives when this good man finds an opportunity presented whereby he can better himself. Here again the hesitancy to increase the cost of the non-productive element in the business asserts itself, and he is allowed to go. His successor is either a new man or one advanced from the ranks. He suggests changes, simplifications, cutting out of what he or others consider superfluous records; these changes do not work out as well as was expected; others are substituted, and before it is realized, the system has lost its vitality and flexibility and degenerates into a simple "cost of product" system.

Now these "simple systems" which cost so little to operate are rarely accurate in their results, and are not productive of the saving that was expected. Simple engines do not require expensive men to handle them, but there is on the other hand a continuous draft upon the coal bin and oil tank. And so it is that in the saving in operation of the simple cost of product system there are leaks in the labor and material accounts which are not apparent and therefore do not localize themselves.

There is no part of a manufacturing business where metals are handled that receives as little attention in the cost department as that which deals with the raw materials. It is generally supposed that where materials are roughly handled in bulk by unskilled labor no accurate methods of accounting can be applied and consequently the most crude records, both of time expended and materials handled, are kept. Averages only are dealt with, and in some instances records are taken only at intervals to see whether conditions change. Such records are worse than valueless; they are deceptive, and the principal object of a cost system is to prevent deception.

The best way to become convinced that records taken at intervals are unreliable and therefore unsatisfactory is to translate them into graphical curves. It will then become apparent, by the distance between the peaks and depressions in the curves, how greatly costs can vary; and when gaps occur, regret will be felt at the lack of knowledge of what has happened during the intervals.

The value of a statement when made by itself may be small, and yet when compared with some other similar statement its full bearing on the subject under consideration is shown and its importance may become very great. Curves show the relative importance of grouped statements, and any variation becomes so striking to the sense of sight as to demand instant investigation.

Let me then urge the advisability of keeping records of the cost of each item of your output every day and all day. Find out what each item costs, so as to learn which is paying and which is not. Try to change your manufacturing methods so as to make your unprofitable product pay, and if you find you cannot do so at market prices, then drop it and let someone else make it.

Try to systematize your processes so that there is a continuous flow of product from the receiving of the raw material to the shipping of the finished product. Remember that every machine and every man in the plant represents capital invested; that when machine or man is idle, just so much capital is not drawing interest, and that the more the machine and the man produce in a given time the greater is the interest on the capital invested. A part of this interest is one of the factors of the profits of the business; the other part should be set aside as a fund to make good the antiquation and deterioration of the machine, and for a long-service pension for the man when he also has worn out. The more continuously the machines operate the better interest they pay; therefore, do not change the work they are set up to perform oftener than is necessary.

The more continuously men work the better interest they pay, for they are keeping the machines from being idle.

Therefore, it will pay to employ men who are steady, who are at their machines every day and all day. These men, even if their output per hour is lower than that of others who are classed as better mechanics, but who are less steady, deliver a greater output per week or per month at less cost. A high-grade cost-accounting system in the hands of scientific management will bring individual plants to their highest efficiency of operation.

In any independent industry it is possible to get the individuals who comprise it to coöperate toward a standardization of methods of cost accounting. If the making of castings stood as such an industry, a movement of this kind would be of very great advantage. In fact, I understand that an effort is being made among the jobbing foundries to get together on these lines. There are, however, so many different kinds of industries which have a foundry as a regular department in their business that it would be impossible to attempt to do more than suggest, by establishing precedents, the general lines which it would be advisable for them to follow. This you can do, and I hope that your initiative will be followed.

Unctuous Graphite

E. G. Acheson, well known for his researches on graphite, carborundum, etc., has recently succeeded in preparing artificially a soft unctuous graphite, suitable for electrotyping and lubrication. The coal or coke is heated with an insufficient amount of carbide-forming material, of which there will be enough in the ashes of the coal. A mixture of 65 parts of ground anthracite and of 35 parts of sand and coal is, for instance, heated in an electric furnace, 18 ft. in length, the mixture being packed around a core of graphite, ⅞ in. in diameter. Surrounding this active zone of 18 in. diameter is a jacket of 1 part of coal and 2 parts of sand. The current, started at 80 volts and 75 kilowatts, is kept on for 15 hours, during which the pressure is raised to 200 volts and the power to 800 kilowatts. About 1000 pounds of unctuous graphite are obtained. When this graphite is ground up with water in a mortar, a black suspension results, the graphite floccules of which settle in the course of a few minutes. When, however, tannic acid and a few drops of ammonia are added to the water, the emulsion remains unchanged for weeks and passes unchanged through a filter. If, then, hydrochloric acid is added to the emulsion, deflocculation takes place. To prepare emulsions of the graphite in oil proved at first difficult; but unctuous graphite emulsions, prepared with water or with light oils, are now offered as lubricants.

Planer-way Protecting Device

EDITORIAL CORRESPONDENCE

Shop men as well as shop proprietors realize the desirability of keeping planer ways free from chips and dirt. Planer hands, particularly, appreciate the difficulty of maintaining such a condition at all times, especially in the case of the larger planers whose beds extend out into the bays served by overhead cranes, where there is a possibility of core sand and other gritty material being dropped upon the ways from castings which are being moved to and fro overhead.

FIG. 1. PLANER-WAY PROTECTING DEVICE

During a recent visit to the shops of the Bullard Machine Tool Company at Bridgeport, Conn., an AMERICAN MACHINIST man was shown an ingenious and efficient arrangement which had been applied to all of the large planers in the works, for preventing core sand, chips, or anything else of an injurious character from getting into the ways. This protecting device, invented and patented by W. A. Thelin, foreman of the planer department, is illustrated by the accompanying engravings. As will be seen from Figs. 1 and 2, it consists of two strips of heavy duck wound upon spools located at the end of the bed, the outer ends of the strips (which are of course somewhat wider than the V's) being attached to the end of the platen at points directly over the ways. The spools are mounted, as shown in Fig. 3, upon a spring-actuated shaft which, upon the platen moving forward, permits the protecting strips to be unwound; the tension of the springs, which are wound up by the forward movement of the platen, acting precisely like a window-shade roller spring to keep the strips taut at all times and rewind them on the spools as the platen returns.

To keep the canvas strips clear of the corners of the bed a pair of rollers carried by swinging arms pivoted in suitable brackets are interposed between the bed and the spools. The pivoted members are weighted and normally the position of the rollers is that indicated in Fig. 1, the weights swinging the arms upward until a stop screw contacts with the end of the bed. In this position the rollers lift the strips above the ways and prevent their dragging on the edge of the bed during the travel of the platen. As the platen returns and the protecting strips are wound up tight on their spools by the action of the springs, the two blocks secured to the under side of the strips come in contact with the rollers carried by the pivoted arms and swing them into the position shown in Fig. 2, out of the reach of the V's under the platen. Upon the reversal of the machine and the forward move-

ment of the platen the rollers again swing up into normal position to lift the strips clear of the edge of the bed.

This arrangement as applied to the various planers at the Bullard shops keeps the ways fully protected from chips and dirt at all times. No matter what the length of the stroke or the position of the platen may be, the protecting strips are kept taut as they are drawn to and fro along the ways; and this feature in conjunction with the overlapping width of the strips precludes any possibility of dirt falling into the V's. It will be noticed that the protecting device interferes in no way with the manipulation of the planer. For instance, if the platen is to be run way back over the ends of the bed to permit oiling or examination of the mechanism, the flexible strips will simply be drawn back and unwound from their spools just the same as if the platen were moving forward, the springs on the spool shaft then preventing the strips from sagging on the floor and the three-cornered blocks keeping them clear of the lower corners of the platen V's. F. A. S.

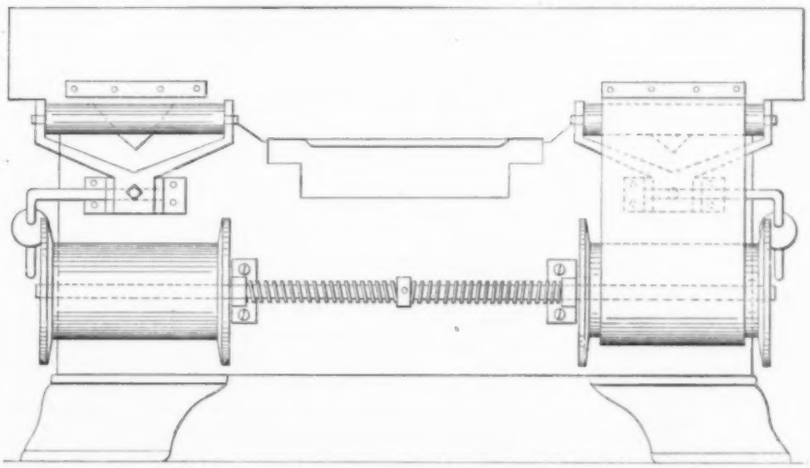


FIG. 3. SHOWING CONSTRUCTION OF PLANER-WAY PROTECTING DEVICE

FIG. 2. PLANER-WAY PROTECTING DEVICE

Tinning Aluminum

A correspondent of *Der Metallarbeiter* asks for a method of tinning aluminum. The reply is of sufficient interest to translate in full.

"This problem has presented many obstacles to the investigator before a practical method that could be commercially utilized was devised. It has finally been found that the only way is to use an intermediate coating of copper, and this must be made as firm as possible. A sufficiently heavy copper coating can be given only by the electrolytic process. A satisfactory solution is made by adding one volume of nitric acid (1.3 S. G.) to 17 volumes of 10 per cent. copper sulphate solution. The best adhesion is obtained when the aluminum is given a matte surface before plating. This is done concurrently with the unavoidable cleaning by immersing the article in a bath of hot concentrated caustic soda until it has a white, blistered apperance. If left in too long the metal becomes rougher and assumes a dirty gray color. This can be washed off in nitric acid, followed by rinsing in clean water. The longer the immersion in the soda solution, the rougher the surface of the aluminum, and if sufficient time is allowed it will be finally all corroded away. The bath for tin plating is a matter of accuracy, as much depends on this point. Three parts of tin chloride and 9 parts of caustic potash are dissolved in 100 parts of water. Add the potash first and warm the water a little until solution is complete, then add the tin chloride. This bath, when in use, must be kept at a temperature between 160 and 190 degrees F. This may be accomplished with a steam or hot-water jacket to the tinning kettle, or even by the use of a gas flame. The bath must be of a uniform temperature throughout, however.

"If these conditions are observed, tin plating begins as soon as the coppered article is put into the bath, and in 15 to 20 minutes the coating will be thick enough."
—*The Metal Industry.*

The export of British automobiles and bicycles and parts has greatly increased. So far this year's value of exports aggregates about $1,500,000 during the first three months, nearly double the value in the like period of 1906.

To blue iron or steel, mix one part clean sand with one part powdered charcoal; heat evenly in a pan until the piece, which has first received its finishing polish and been covered by the mixture, comes to the desired color. When cool, wipe dry with a cloth.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Removing Burs from Screws

At page 403 is an inquiry for information as to removing burs from the slot in headless screws.

We were building a special machine that required twenty-four ⅜-inch headless screws with polished ends. These came to us in blue and with burs. I undertook to polish them with a block of wood and emery cloth. This method had very little effect on the burs, so I cast about for other means.

In looking through a collection of odds and ends in the tool room I ran across a piece of emery wheel; this I put in the chuck of the speed lathe and with a piece of soapstone struck a small circle while the machine was running. I took a cape chisel ⅜-inch wide, ground to the shape of the screw head, rounded the corners, tempered it as hard as possible and started the machine, holding the chisel as near the center as I could without touching, tapped the chisel with a light hammer and soon had a hole ⅛ inch deep and slightly less in diameter than the screw. Then taking a small pair of pipe pliers, to hold the screws, and a can of soda water, I gave the stone a dose of the water and forced the screw into the hole. The result was not only the removal of the burs but a fair polish as well.

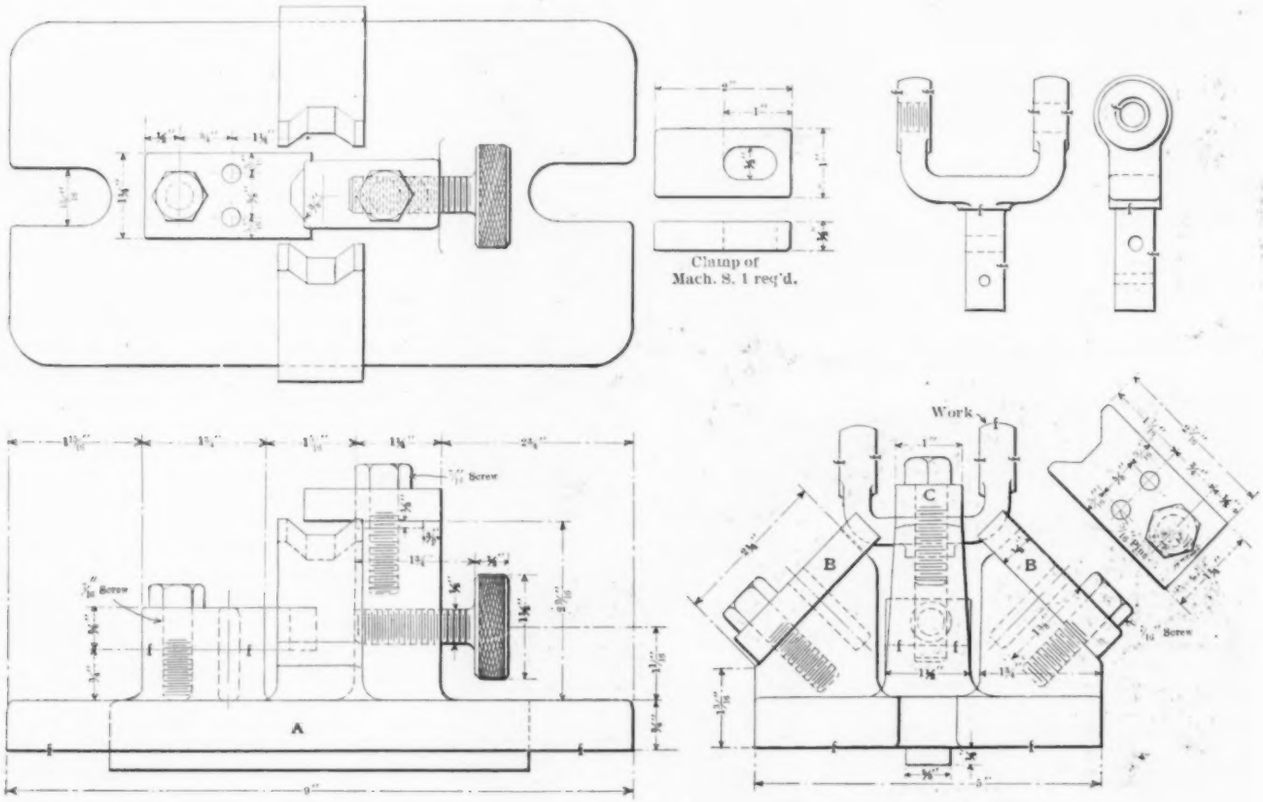
To get a finer polish you could use a block of wood the same way and force fine emery into the wood, or tack on a piece of emery or crocus cloth after making a slight depression in the wood.

J. WATSON.

Fixture for Milling Ears of Yokes

To mill the ears of small yokes the little fixture illustrated herewith is well worth trying. *A* is a cast-iron base, with tool-steel vees *B* screwed in place, by which the work is located; with a thumb screw to center the stem and a clamp at *C* the work is held rigid. The fixture being bolted longitudinally to the table, and straddle mills being used, it does its work very well.

GERALD.



FIXTURE FOR MILLING EARS OF YOKE

Diagrams versus Formulas

I note your remarks as to the benefits to be derived from using diagrams in the place of formulas. Are all the advantages on one side? Is it not possible to so condense the matter in a formula that a pocket-book will contain more information than if diagrams are used?

It is needless to mention that the diagram is the easiest way of imparting information; still, I think that there is a point in all study (may be called the receptive point) where one can plainly see the way. Anything that can be learned in a short time is apt to be as soon forgotten. I hardly think from the wording of your article that you really desire a complete change. What diagram would you use to illustrate $\pi = 3.1415926$?

So many good formulas have been devised, and are accepted today without question, that any rule would have to be subject to exceptions, and, admitting one exception, the question would still be left to the judgment of the author.

I remember one *bete noir* in the shop. What constant can be used to find the correct spacing of holes on a circle! The only one I know of is the one used to determine polygons, and as a matter of fact the table is generally useless in a shop, since any man with some idea of geometry can bisect and trisect in one-half the time that he can perform the calculations. What I mean to emphasize is this, that the dimensions would be accurately given on the drawing or diagram or sketch if they were of any practical use.

A. N. HAMMOND.

A Cheap Shop Fan

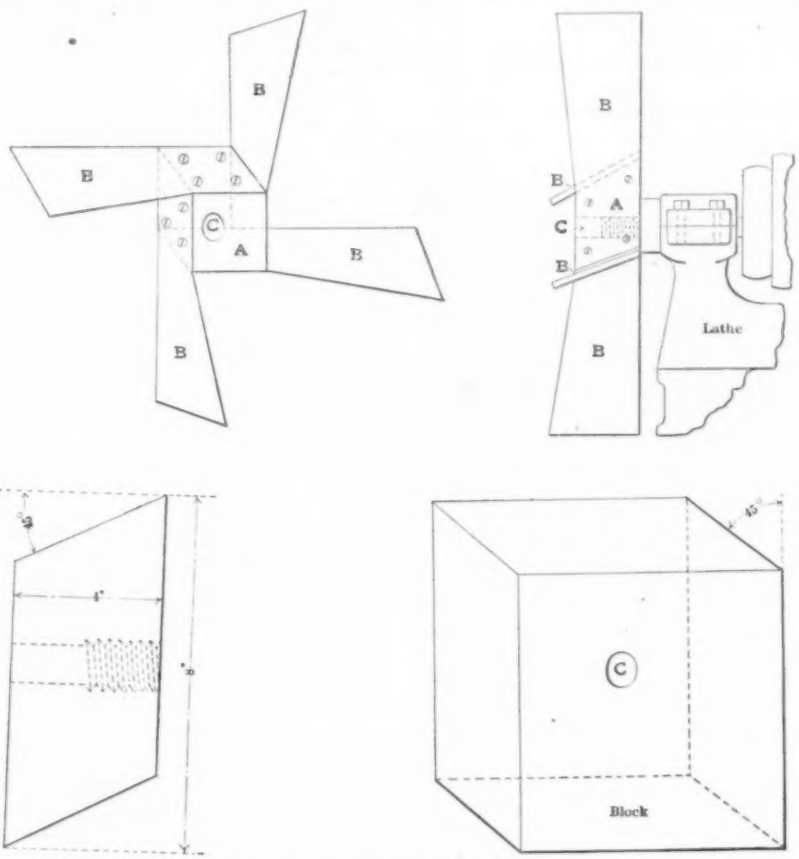
Last summer I was employed in a factory in which the machine shop, smith shop and wood- and metal-pattern shops were on one floor. All these departments were in one large room without any partitions, so that on a hot day the heat was unbearable. To make matters worse, the pattern shop faced on the alley and directly over the large boiler room. The heat from the smith shop and metal-pattern shop, together with the heat and gases from the boiler room and the hot sun, cannot be described. It was next to impossible to keep the workmen more than two or three hours each day. The work was going behind and something must be done to keep the workmen all day.

I send a sketch, Fig. 1, of a simple, inexpensive fan that did the work. One of these fans was put on the wood-turning lathe in the pattern shop and one on the end of a polishing or grinding stand in the smith shop.

Make a block, as in Fig. 2, of pine; bore a hole about 3/32 inch smaller than the diameter of the outer end of the lathe spindle; cut four sides on a 45-degree angle; make four blades ½ inch thick by 24 inches long and secure to the block with screws; cut a thread in the block by screwing on the spindle or fastening to the lathe face plate.

In the shop where I am now employed the apprentice boy is making ten of these fans.

A. B.



MAKING A CHEAP FAN FOR THE SHOP

Cutting Premium Rates

The writer would like criticism, advice and such information from those who have had extended experience with the premium plan as will help in straightening out this tangle.

GENERAL STATEMENT

In manufacturing a small machine, the individual pieces are made in large quantities and are interchangeable or practically so. The pieces are put together by bench hands to form various subdivisions of the machine. The individual pieces have to pass a rigid inspection before they are put together in the subdivisions, likewise the subdivisions before they are put together to form the complete machine.

The Halsey premium plan has been used in a limited way for some time, and has recently been extended to cover practically all the building of the subdivisions. The men are allowed full pay for one-third of the time saved from the time limit. All time limits are based on an arbitrary rate of 20 cents per hour. On the principle that equal work should receive equal pay, if the man's day rate is 20 cents per hour, then his actual time limit and the theoretical time limit are the same, but if the man's day rate is 25 cents per hour, then his actual time limit is $20/25 = 4/5$ of the theoretical time limit. Likewise if a boy whose day rate is 15 cents per hour, can do the work, then his time limit is $20/15 = 4/3$ of the theoretical time limit.

Total No. Pieces.	Total Hours.	Total Cost.	Rate Per Hour.	Hours Each.	Cost Each.	Hours Each at 20c Hour.
11	139¾	$32.03	23	12.7	$2.91	14⅝
42	398⅝	95.82	24	9.5	2.28	11.4
39	424¾	100.92	24	10.9	2.59	12.95
				Average.....	$2.59	12.95

TABLE 1. ORIGINAL TIME, WAGES AND COST.

The method of establishing the time limit has been to make it a little less than the average time taken to do the work by day rate, reducing it to the basis of 20 cents per hour by the above principle.

The class of workmen employed are bright men and boys, who are carefully selected, who have good health, education, at least as far as the grammar school, character, and some experience in a similar line of work. They are therefore above the average of the operating class of help.

Total Pieces.	Time Limit.	Time Taken.	Time Saved.	Day Rate Per Hour.	Increase in Wage Per Hr.	Labor Cost Per Piece.
8	64	63⅛	⅞	30c.	.001	$2.38
10	108	63¼	43¾	22	.048	1.74
10	96	43⅛	52⅞	25	.101	1.52
20	200	62	138	24	.178	0.796

TABLE 2. PREMIUM TIME, WAGES AND COST.

EXAMPLE

A certain subdivision was first put together by day labor, of which a record is given in Table 1.

The average time for the 92 pieces is therefore 12.95 hours each when reduced to a basis of 20 cents per hour. The the-

oretical time limit was set at 12 hours each at 20 cents per hour.

Several hundred of these subdivisions have been put up, a number of different operatives working on them at various times during the past few months, with the results given in Table 2.

In the above table, for the sake of brevity, only a few of the entries are given, each one for a different operative, the arrangement being in the sequence of their occurrence.

The labor cost of these subdivisions has therefore decreased from an average of $2.59 to $0.796 each, or a decrease of 69 per cent., while the last operative increased his wage from $0.24 to $0.418 per hour, or an increase of 74 per cent. In other words an expenditure of $1 in premium money has produced extra work of a value of $3.

Question

The point at issue is that the manager is not satisfied with this and other similar results.

He says the cost would decrease materially even if we had not had a premium, on account of the men becoming more accustomed to the work, and to general conditions that conduce to a decrease in cost, which is, of course, true; that to increase a man's rate to this extent is unreasonable. He does not object to a man's making an increase of 33⅓ per cent. on a premium job, but objects to its going higher. He says the ideal would be to get a ratio of work to premium of 10 to 1 instead of 3 to 1, as the above. At the same time he would object to giving the operative one-tenth of the time saved, and thinks it would be better if we gave one-half instead of one-third. In his own words he asks:

"What is a reasonable percentage for a workman to increase his wage under a premium plan? Is an increase of 66⅔ per cent. excessive? A man drawing 25 cents an hour is presumably a 25-cent man in intellect and general ability. If under a premium plan, by reason of some knack which he may have—which knack may even conceivably be a defect, such as being left handed, deaf, etc.—he draws an increased wage of 66⅔ per cent., or 41⅔ cents an hour, we are paying a 25-cent man a 41⅔-cent wage. For the immediate present this is probably profitable to the employer, since he decreases his cost thereby; but what is the ultimate effect upon the workman of this wage in excess of his normal worth? It takes a strong man to stand up under increased prosperity, particularly when it comes really without conscious effort on his part. How does the ordinary laborer stand up under it? And what is the effect upon the value of this man to the employer? Does not this excessive wage under some particular premium destroy his usefulness for anything thereafter?"

The time setter would like to know what is wrong with his application of the premium plan. Is there an error in setting the time limit? Because a man in a few months increases his rate from 24 cents to 41⅔ cents, is this a reason for thinking the time limit is wrong? Is the one-third to the employee wrong as applied to our particular line of work? Is he allowing a greater inducement than is necessary to bring out the best endeavor of the employee? If the time limit is right and the employee's one-third is right, then as he understands the premium plan, it is extremely undesirable to put any limit whatever on what rate the man makes. It has been his repeated experience that exceptionally good men will eventually do their work in one-third the day-rate time. Are there others who have had the same experience?

In the foregoing the writer has tried to state every condition and fact pertinent to the question at issue, and it is his hope that someone will be able to grasp the situation, and by advising us help to set us right. W. P. C.

[Our opinion will be found in the editorial column.—Ed.]

Screw-slotting Jaws

Our factory uses several hundred thousand machine screws every two or three months, and as I have charge of the slotting of these screws I find it more of a job than it looks to be.

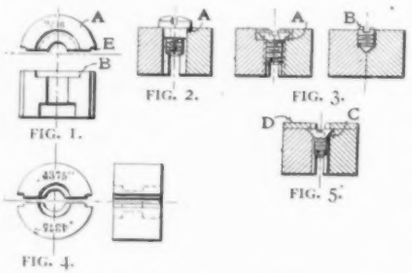


FIG. 1. FIG. 2. FIG. 3. FIG. 5.

FIG. 4.

SCREW-SLOTTING JAWS

A great many of the screws are fillister-head shoulder screws, as shown at *A*, Fig. 2; some are flat head, as shown at *A*, Fig. 3; and some are headless, as shown at *B*, Fig. 3.

The old jaws were mostly made like Fig. 2, just a pair of half-round blocks ⅝ inch long, with a half hole or half-round groove down the center, which fits around the shoulder or body of the screw to clamp it while the slot is being cut. These blocks also have a corner cut out as at *E*, Fig. 1, to fit the retaining plates on the slotting device. As a good many of the screws were threaded up to the head or else had a shoulder under the head, they had to be held by either one or the other while slotting. This invariably caused trouble from bruising the shoulder or mashing the points of the threads so that they could not be used.

As I got to where I needed some new jaws I had them made up so that instead of holding the screws as shown at *A*, Fig. 2, they were counterbored deep enough to fit the heads so the head would drop down, as shown at *A*, Fig. 3. A flat head of the same diameter as the counterbore, and with a body that just fits the lower grooves is held firmly, with no danger of mashing the threads.

I had a pair of jaws made as shown at Fig. 5, for holding flat heads, but I found that while it worked well enough with 3/16- or ¼-inch screws, it did not do so well with a No. 2x56, with a body only ⅛ inch long, the head being 5/32 inch diameter.

The plates *D*, Fig. 5, were fastened to each half of the jaw, and were countersunk the same as the jaw at *C*, but a trifle larger. These plates were the thickness of the head of the screw, and were intended to help hold the screws in the jaws without letting the jaws come up against the body and mash the threads. As the screws were so small it was impossible to handle them with anything like speed. When the jaws were opened wide enough to let the head pass the plates and drop on to the jaws, as shown at *C*, Fig. 5, they were apt to drop clear through into the pan.

Taking a pair of jaws like those shown at *A*, Fig. 3, which had a 5/32-inch counterbore and grooves to fit the body of the No. 2x56 screws, I had the boy try them and was very much pleased to find that where he had been slotting 75 to 100 per hour the old way, he slotted from 500 to 600 per hour with these jaws.

The headless screws are ⅛ inch by 44th and ⅛ to 5/32 inch long. To pick these up one by one and put them into the jaws with the point down is quite a task. We get them done in pretty good time by using jaws like those at *B*, Fig. 3, and do not get the threads mashed.

Fig. 1 shows an end view of a jaw counterbored at both ends, one end being ½ inch and the other 9/16 inch diameter, the groove being ¼ inch. The jaws are all ⅝ inch long and are made of machine steel; the diameters of the counterbores are stamped on the faces so that a jaw may be found by looking at the sizes. *B*, at Fig. 1, shows the different depths of the counterbores, which may be made in any combination desired.

Fig. 4 gives an end and side view of the two half jaws assembled; these jaws are turned up true 1 inch diameter, the holes bored the required size, and then cut off. After the groove *E*, Fig. 1, has been milled, they are counterbored, sawed in-half, the sizes stamped and then case-hardened. When sawing the jaws apart, the cut is made 1/64 inch or more wider than the thickness of the saw to be used in slotting the screws which that pair of jaws are to hold.

The jaws shown at *B*, Fig. 3, are made and parted before the hole is drilled. After the hole is put in, the faces are

worked down, so that the jaws will close the hole enough to hold the screws without injuring the threads. The bottom of the hole is made to fit the point of the screws, though this is not necessary. I find these jaws give greater satisfaction than any others that have been used.

A list of the numbers of the screws in the order that they are made, with the number of the saws to be used, saves lots of time hunting the right-sized saw for the screw to be slotted.

Where boys are employed for this work it takes a great deal of one's time watching the work to see that they do not spoil a lot of screws by getting the slots not deep enough or too deep, off center or deeper on one side than the other, and to see that they make a clear cut, the right width.

GEO. G. LITTLE.

Turning Tapers with Compound Rest and with Tailstock Offset

A quick and convenient way of finding the required taper per foot on the compound rest: Cut a piece of new tin, say

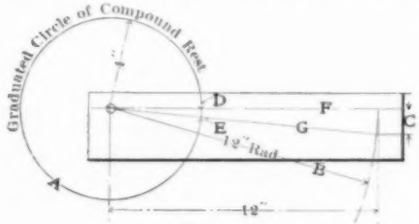


FIG. 1

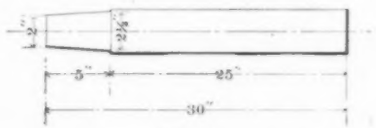


FIG. 2

TWO WAYS OF TURNING TAPERS

5x14 inches, as per sketch Fig. 1. Scribe a radius on it equal to compound-rest radius *A*. Also scribe a radius equal to 12 inches, *B*. Lay off required taper per foot on the 12-inch radius at *C*, and set divider points at *D* and *E*, where the compound-rest radius intersects center line *F* and the line *G*, which is the angle formed by the required taper *C*.

Now place one divider point on the zero of the compound base, loosen compound and move in the desired direction until zero on compound rest lines with other point of divider.

This is a very simple method of catching any taper on the compound rest, where the taper per foot is known.

A short-cut in finding the right amount to set tailstock over when turning taper work on centers, from measurements at each end of taper:

Example from Fig. 2:

$$5 \,\Big|\, \frac{30}{6} \quad 6 \times \tfrac{1}{4} = \tfrac{6}{4} = \tfrac{3}{2} = 1\tfrac{1}{2} \text{ inches.}$$

Divide whole length of work by length of taper part; multiply quotient by one-half the amount of taper required. Set tailstock to the answer.

M. F. PARSONS.

Which Way Should Splices Run?

I would take issue with H. M. Wolf's article, on page 740, on why the laps part. In 20 years' experience with lathe belts under varying conditions I never saw one start to open on the inside or side next to pulleys, but they always start on the outside.

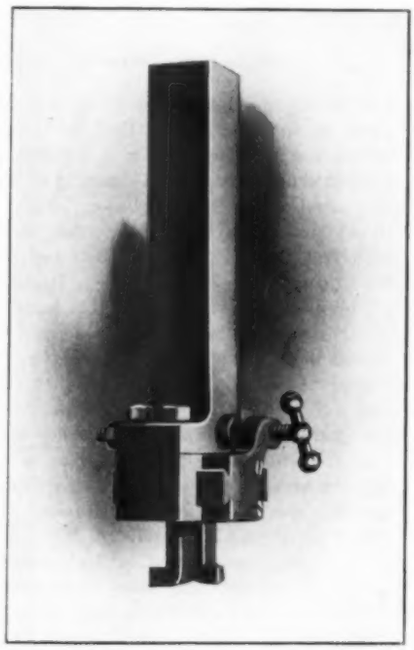
The theoretical reason for this is that the action of the belt in bending around the pulley puts more strain on the outside than on the inside, then the thin end of the lap gets started ever so little; the wind pressure keeps up a constant strain on it. The faster the belt travels the more strain from wind pressure. The rule in all shops that I know anything about has been to run the heel of the lap to the wind.

W. A. B.

A Planer Tool for Tee-slots

The half-tone illustrates a tool which I have used to advantage for planing tee-slots.

It is made entirely of steel. The shank



A PLANER TOOL FOR TEE-SLOTS

is 1⅞ inches square and about 10 inches long, with a wide bed to which are secured dovetailed pieces, one on each side, which carry slides with the cutters strapped to them. The cutters are forged from 1x½-inch high-speed steel and are securely fitted in slots in the slides.

Two cutters are carried by the tool, one right hand, the other left. They are fed by means of a right- and left-hand screw which passes through the holder and has a handle on the side toward the operator. One cutter is 5/8 inch behind the other; this space is enough to allow the chips to clear.

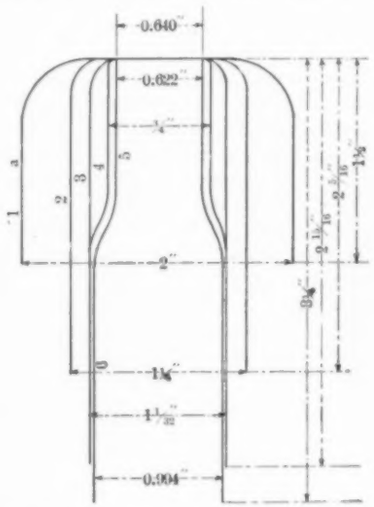
This tool not only saves time, but also saves high-priced steel. Before this tool was made it required a pair of tools, each made from a piece of steel 1½x¾x10 inches, to do a job of planing tee-slots. After a few dressings these tools were too short and had to be discarded. Now a pair of cutters 1x½x3½ inches does the same work. In our plant I have done all of the tee-slot work for the past two years with three sets of cutters. The work was on radial-drill tables and beds for taper-attachment lathes.

The tool should be of value in planing platens for metal planers.

DANIEL E. CONLON.

The Stretch of Brass in Shell Drawing

At pages 704 and 705 I gave a description of a set of shell-drawing dies for a single-acting press, closing the article with the remark: "The most interesting feature of the drawing of such shells is the



STRETCH OF BRASS IN SHELL DRAWING

stretch that the metal will stand under strain." It is not my intention to make a scientific explanation, but to give facts supported by actual measurements, taken from the shells from the first to the last operations.

In the illustration *A* is the first operation, showing the top of the shell with a very large rounding on the corners. This was done to secure new metal to start the second operation with. The blank of the first operation was 3¾ inches diameter, 0.012 thick. The shell drawn from it was 2 inches diameter by 1½ inches deep. Measuring the shell from one bottom edge across the top to the other bottom edge, it measured 4½ inches, a stretch in the metal of ¾ inch. The metal maintained its original thickness of 0.012 throughout.

The second operation was to redraw or

reduce the first drawn shell from 2 inches diameter and 1½ inches deep to 1¼ inches diameter and 2 5/16 inches deep. The metal stretched from 4½ inches to 5¾ inches when measured as before, and the metal was reduced from the top downward gradually to 0.011, but retaining its original thickness toward the bottom edge.

The third operation was after annealing the shell, to reduce it from 1¼ inches diameter and 2 5/16 inches deep to 1 1/32 inches diameter and 2 15/16 inches deep. Measuring the shell as before, it was 6¾ inches, a stretch of 1 inch; besides this, the thickness of the metal was reduced to 0.010 at the top and remained 0.012 at the bottom.

The fourth operation was to reduce the upper part of the shell from 1 1/32 inches diameter and 2 15/16 inches deep to ¾-inch diameter and 1 inch long. This operation stretched the upper part so much that the shell, when measured as before, was 7 inches from bottom to bottom edge, a stretch of ¼ inch; the reduction in the thickness of the metal was hardly perceptible. The sizing operation of the large end of the shell stretched it another ¼ inch and the sizing of the small end still another ⅛ inch, besides reducing the metal in this small end of the shell to 0.009, the required thickness.

The measurement over the finished shell from bottom edge to bottom edge was 7⅜ inches from a blank of 3¾ inches diameter, or a stretch of nearly 100 per cent. This was the limit; the top corners of the shells would stand no more stretching.

Measurements taken from a number of shells showed a little variation in length, from 1/64 to 5/64 inch; this was probably owing to the unevenness of the brass.

JULIUS F. A. VOGT.

High-efficiency Fly-wheel Joint —A Criticism

In the issue of May 16 I notice a fly-wheel joint design by A. L. Haas.

Let us assume that we have a compound engine of 5000 horse-power, and wish to place a fly-wheel of his design between the two cranks. Such a fly-wheel might be 20 feet in diameter and weigh 50 tons. If we first shrink on the bands and then force the shaft into place, the rim might as well have been cast solid at first, as the hub is cast split and will relieve shrinkage strains. This is sometimes done with small wheels which can be assembled on the shaft without splitting. On the other hand, if we first bolt the two halves of the wheel on the shaft, it will be rather difficult to get the hot bands in place.

It seems to me that there would be serious difficulties in either plan, especially if all the special appliances of the shop were not at hand, as is usually the case in the power house. When once in place the wheel undoubtedly would be a good one until someone wanted to take it apart.

SMITH FARIS.

Mistakes Due to the Abbreviated Drawing of Screw Threads

At page 495 is a criticism of the method of showing screw threads in a hole by means of two double rows of dotted lines. To give point to the criticism, there are shown two drawings, one of two pieces held together by a fillister-head screw, the other of the screw as it was found to be when taken out in the drafting room for the purpose of making some changes for new work. The drawings are reproduced herewith in Figs. 1 and 2, but with the addition of the dimension, ⅜ inch, in Fig. 1.

While it is obvious from an examination of the drawings, that the two screws (i.e., that shown assembled in Fig. 1, and

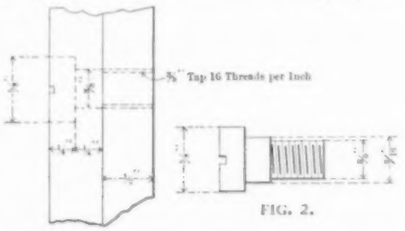


FIG. 2.

FIG. 1.
SHOWING SCREW THREADS

that shown in detail in Fig. 2) are not the same, it does not follow that the screw was made, as shown in Fig. 2, because of a misinterpretation of the meaning of the two rows of double lines. Fig. 1 shows a screw in which the space between the head and the end of the thread has the same diameter as the outside of the thread. In Fig. 2, the screw has between its head and its thread a shoulder 1/16 inch larger in diameter than the diameter of the thread, and it is difficult to understand the manner in which the drawing could have been read to reconcile the two. It seems to me that in view of the fact that there presumably was to be no detail drawing, the diameter of the body size of the screw should have been shown in the assembly drawing. If this had been done as indicated in Fig. 1, there would seem to have been no excuse for making the error described.

The method shown in Fig. 4, page 495, is without doubt the better way to show screw threads in such cases, its only disadvantage, as compared with other methods being the greater length of time necessary.

L. A. M.

Referring to the article at page 495, it would seem that Fig. 1 there shown, is incomplete, as it does not give the drill diameter; therefore the machinist has no way of telling whether a shoulder screw or an ordinary screw is needed. If the drill diameter had been given as 15/32 inch, or 13/32 inch, if 1/32 inch is sufficient clearance for the work, the question of style of screw would be settled.

A better way of doing it seems to leave no room for doubt in the workman's mind. Take Fig. 1 and draw either the two double lines, as shown, or draw as in Fig. 4, using dotted lines. I prefer the latter method, as it cannot be mistaken for something else. Then mark the hole "⅜-inch tap 16 threads for ⅜x¾-inch fillister screw"; or if a shoulder screw is required, it may be a standard shoulder screw used in the shop and can be referred to by its number. If a special screw of any kind, it would then have a part number under the machine on which it is used, and the note would read something like this, "⅜-inch tap for R 23," and the drawing of "R 23" will tell the rest. As to the kind of thread to be used, the standard shop thread, V, U. S. Standard or other would always be used unless otherwise stated.

Fig. 2, which the article says shows the correct method of showing threads, has the thread lines drawn at an angle to the axis, which is also unnecessary. If they are drawn at right angles to the axis, the draftsman can use his regular triangle and T-square, and save the time necessary to change tools or swing his T-square.

Of course it is understood that right-hand threads are always used unless marked otherwise. In a dotted thread shown with oblique lines, there is always a chance for a question about the hand of the thread, unless there is a note explaining; so why not save time and draw the lines at right angles?

C. J. FRY.

Individual Motors for Machine Tools—Points in Regard to Standardization

In his article on the standardization of machine tools, A. L. Pratt, page 663, certainly advances a point which seems theoretically to be beyond reproach. Considered from a practical standpoint, however, I fancy that his idea of manufacturers falling into line (although they do so now to an extent) is hopeless. He quoted the case of grindstones and wishes us to notice that the smaller grinder is driven by the stronger motor. Obviously these machines were designed by different men, each of whom wished his grinder to run at a speed which he considered the best for all-round purposes, such a speed depending upon the composition of the stone and the tools to be ground. Obviously a predetermined speed cannot be set down for all shops and conditions. Other things being equal, different speeds mean different driving powers, and because a difference of 0.4 horse-power is present we cannot cavil, even though at first glance

one would feel inclined to apply each motor to the other grinder.

J. STONEHAM.

R——, England.

Repairing a Steam Ore Stamp

The following incident happened while I was employed in a copper mine in Michigan.

After the rock is mined underground it is sent to the mills to be crushed until all the rock is separated from the copper. The crushing is done by what are called stamp heads; see Fig. 1. These stamp heads are built on the principle of a vertical Corliss engine, with the exception that instead of a connecting-rod it has a massive ram that dashes down in a mortar filled with ore and water. The valve motion is driven by an eight-inch belt—not shown. Some idea of the crushing power of these heads may be formed by noting the dimensions, the bore being 21 inches diameter, stroke 26 inches, steam pressure 140 pounds and weight of piston, piston rod, and ram about three tons. The number of strokes per minute is about 120. The rock is fed into the mortar through a hopper by gravity. A tell-tale gong is struck by the ram when rock is not being fed into the mortar fast enough. The constant jarring on the piston rod sometimes loosens the nut holding the piston, and this can be noticed only by a slight click on the end of the strokes.

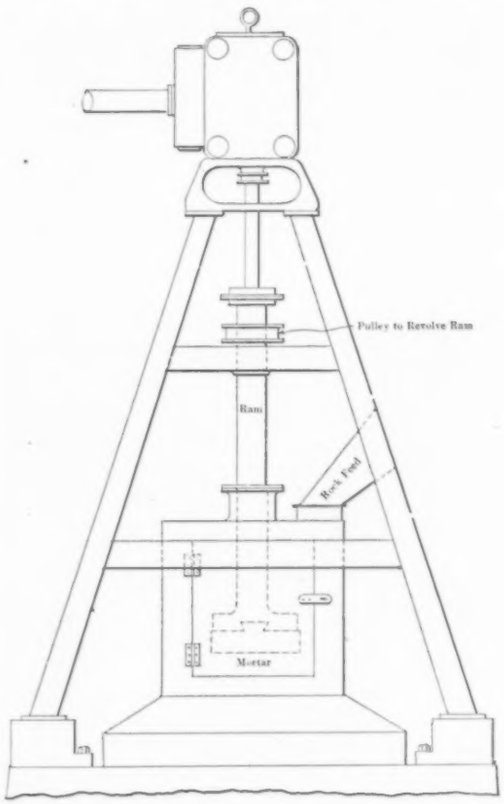


FIG. 1

THE STAMP AND THE DIE

It happened one day that the nut stripped the thread of the piston rod, the result being the piston and cylinder cover went sailing up to the roof. We always have on hand new cylinder covers and pistons, but no piston rod and nut, as this was something unlooked for. To take out the ram and piston rod would take a day and another day to put in a new one, even if we had one. I might here say that while one of these machines is standing, it is losing money at the rate of about $30 an hour, as the mines are constantly mining rock and shipping it to us. To stop the stamps would mean throwing a good many men out of employment and would demoralize the freight schedule of the railroad.

I set men at work clearing away the wreck and putting new studs in the cylinder. I had a piece of steel which we forged to the shape and size of the damaged nut. Then I bored six holes,—see Fig. 2,—plugged them and then bored and threaded it in the lathe so as to cut a full thread on the damaged piston rod. I cut a slot almost through. (The reason for not cutting it through was, I was afraid when I came to harden it it would warp out of shape.) I then hardened it, drove out the plugs and also broke out the piece I had not quite sawed through. After grinding, I was ready to try my luck at cutting a thread of 9 to the inch and 3½ inches diameter. I got several small wedges and placing the improvised die in the box wrench we have for tightening the piston nuts, I drove the wedges into the slot as far as I dared. Having chamfered the end of the piston rod, we gradually started a thread on the rod. I had previously had a man drill ½-inch tap holes in each side of the box wrench, and after we had run the die down we took out one of the wedges and tightened up on the screws. By dint of perseverance we gradually cut a first-class thread on the rod. While we were doing this I had the blacksmith close up the old nut and then had it threaded to the new size of the rod. The total time taken on this job was about 4½ hours. This rod was still in use when I left there, nearly two years afterward.

G. H. H.

FIG. 2

A Pump Experience

The pump experience related by George, on page 766, recalls to my mind a troublesome pump which I once interviewed at the request of my employers.

The pump was to be an auxiliary in a mill. It was a large one-piston type. All of the work of installation was done under the plans and supervision of the mill superintendent; we merely furnished the pump f.o.b. the cars.

After it had been shipped a few weeks, a letter came saying that it would not run properly; so I was detailed to investigate. A superficial examination showed no trouble; the work of setting up and piping was done in a manner above the average.

I looked over the water supply; it was ample, coming from a small pond or enlargement in a creek.

The suction pipe was about 1000 feet long; 800 feet of it was straightaway, and then it branched into two supplies, one going to an old pump and the other to the new one. At the fork of the branch was a manhole.

I went over and looked at the old pump; it was running as easily as anyone could wish. I then went to the new one, looked her over in detail, blew her out, opened her lubricator and oil cups and carefully gave her steam.

She took three or four cylinderfuls of water, and then jumped and thrashed enough to loosen her up all over had it continued much longer. I closed the throttle.

It looked as if her supply of water was insufficient, as if there might be air binding. To get a chance to think I strolled down to the pond again. Coming from the fore-bay was a long, open channel up to the end of the suction main.

I threw in a telltale and estimated the rate of flow of water in this channel; it was an easy current caused by the draft of the old pump. The telltale I let pass through to the manhole at the fork of the branches and found the velocity in the pipe quite uniform compared with the open channel, and apparently there were

no obstructions. All the while I was thinking.

I then hunted up the superintendent and asked if he had anyone around who saw the pipe laid from the manhole to the new pump. He said, "Yes," and sent for his yard boss. A tall, brawny, good-natured Irishman answered the summons. I asked him a few questions about the branch pipe, one of which was regarding the slope. "Begorra, yis," said Pat, "that pipe is laid to as even a shlope from one ind to th' other as the serface of th' pond that houlds th' watter." "But are there no humps or hollows in the pipe?" I continued. "Indade, no, there be—but yis, Oi remamber there 'do be wan little hump about the bigness of it, where it goes over th' sewer, in the middle loike; you see Oi culdn't go benayth th' sewer. Oi culdn't go troo it, so Oi humped over it."

"May I have some men to dig for that hump?" said I, turning to the superintendent. A few hours of shoveling reached the pipe. We cut into it, fastened in place a 2-inch wrought-iron pipe riser long enough to extend a few feet above the floor, for an air vent, and now I was ready to try the pump. It ran as quietly as it had previously run noisily.

A. L. P.

Tests of a Speed-change Gear Box

I have read Richard C. Williams' article on the above subject, at page 684, Vol. 30, Part 1, with much interest, as it appeals to me in two respects, first as a gear cutter and secondly as a designer of automobile gears. I greatly regret that Mr. Williams has not gone a little farther and told us his opinion as to the reason of these differences in the efficiency of the various speeds. I am therefore writing this, not so much as my theory, as to get others to give theirs.

I quite agree that some manufacturers, or perhaps it would be more correct to say salesmen—the terms being by no means synonymous—give widely varying estimates as to the efficiency of their gears; but I think there can be no doubt, in view of the facts given, that if ball or roller bearings had been used in this box the efficiency of the gear would have been much higher than many of us would have thought possible in ordinary commercial work.

What are the Causes Acting to Vary the Efficiency?

As nearly as I can see, the efficiencies are, for first, second and third speeds and reverse, 95, 92½, 90 and from 78 to 60 per cent. What I should like to know is what causes these different efficiencies.

I wish it to be plainly understood that I am not what is termed a theoretical man; therefore if I say things which are absurd, please accept this as an explanation. In the first place, I always thought that accurately cut gearing was equally efficient at all speeds and at all loads. This idea is pretty well borne out by the tests of the three forward speeds, but I am very much surprised that there is such a slight difference in the three speeds, for this reason: I take it that the power absorbed by the bearings is the same in all cases, and therefore all we have to deal with is the gears themselves.

Why Is There Not More Difference between the Friction in Direct Drive and in the Next Speed?

We have then in the case of the third speed none of the gears doing any work and only one pair running idle, this being the much vaunted "direct drive on top speed" of automobilists; now in the case of the second speed we have two pairs of gears doing actual work, and these two pairs absorb only 2½ per cent. of the motive power, whereas the bearings and one pair of idle gears absorb 10 per cent. This is the first point where I am surprised.

Now in the cases of the second and first speeds we have exactly the same conditions; yet there is a difference in efficiency of 2½ per cent. Why is this? I can only suppose it is because of the difference in the sizes of the pinions, and this again only bears out what I should have expected.

The Greater Loss and the Varying Efficiency in Reverse Gear

Now we come to the case of the reverse. Here we have three pairs of gears in operation (or nearly enough for the purpose of argument). Are we to suppose that while two pairs will absorb 12½ to 15 per cent. of power, three pairs will absorb 22 per cent. or (deducting power absorbed by the bearings) a difference between 2½ and 12 per cent? Again it would seem that the mere fact of putting in another pair of gears alters the law (made by myself, granted), and that now the efficiency varies with the load.

Can someone give me an explanation of these facts, as it may be of great assistance to me, for this reason: I recently designed a gear box for an automobile the engine of which was in capacity far below its work and I noticed the same fact, viz.: that whereas the first, second and third speeds all drove the vehicle at the speed I had calculated, the reverse failed to move it. I should mention, however, that this gear was on the epicyclic principle, with all the gears locked solid on the top speed, so that the numbers of gears in use were always the same; the two cases, therefore, are not analogous, but perhaps there is some explanation which will cover both. Anyway I should like to hear someone else's views.

R. P. Bradley.

England.

Pitch or Lead of Screw

In the article on page 703, under the heading, "What Are Lead and Pitch of Screw Threads?" I do not agree with Mr. Babbitt, in regard to his sketches as shown.

Fig. 1 shows a single thread in which he says the distance from one thread to the next thread is the pitch. The pitch of a screw, as I have always understood it, is equal to the number of threads per inch. Now then, if a screw has 8 threads per inch, it would be called an 8-pitch screw. The same holds good on a lead screw on the lathe. Suppose a lead screw on a lathe has 4 threads per inch, we would then call it a 4-pitch lead screw. What Mr. Babbitt calls the pitch in Fig. 1 of his article I would call "inch pitch."

In Figs. 2, 3, 4 he says the pitch is equal to the distance from point to point of the thread. This I would call the "lead." As he shows a triple thread I would therefore call the advance of one turn of the screw the *lead*, and not the pitch.

The "inch pitch" in the triple-thread screw would be the same as a single thread providing the number of threads in the first and last cases is the same per inch.

Edw. J. Rantsch.

Turning Ends of Square Bars

The discussion on "Turning Ends of Square Bars," with box tools of four and five cutters has interested me greatly, as I have had the same problem to deal with.

I am running a job on which we turn down several hundred bars daily with box tools having three cutters. These cutters having no top rake, tear the steel to a considerable extent, and so must be followed by a hollow mill to smooth the surface and square the shoulder.

For small sizes an ordinary single-cutter box tool with back rest, is all that can be desired, but above one inch no machine that I am acquainted with has a sufficiently rigid tool to stand the unequal strain upon it.

My wish is to get a smooth cut with but one operation, reducing 1⅜-inch square bessemer bar steel to 1¼ round with a tool that will stand 1/50-inch advance per revolution.

Mr. Bright's box tool, with five cutters, should reduce the tendency toward tearing the metal, yet I believe a slight top rake would go still farther toward smooth cutting. I would like to hear from those who have solved this question to their own satisfaction.

E. M. Rigsby.

In order to facilitate removal and insertion, a gasolene-engine spark plug, recently illustrated in the *Autocar*, is made on the principle of the breech block of a cannon, i.e., with an interrupted screw thread.

Making a Chain without Welds

Chain making is one of the branches of blacksmithing which still depends on hand work and on the careful welding of each individual link depends the strength of the chain as a whole. There have been processes devised for forging a chain under heavy pressure, between dies which formed the links from the solid stock without a weld, but the metal was so crushed, and, in the case of iron, the grain was so broken that the result was not gratifying in any way. Small chains are made from wire by bending and twisting but for chains of any size, from ½ inch up, the weldless chain has been a theory rather than a fact.

An interesting process of making chains without welds has been devised by Stefan von Ecseghy, an Austrian engineer, and the details of this are interesting in many ways.

How It Is Made

Starting with a blank of 5/8 inch round stock the center is swaged down as shown at *A* in Fig. 1, leaving a bar about 6 inches long, with enlarged ends. This is then ready for the real chain making, which consists of a set of three dies, one back of the other in a heavy press.

The first die of the series flattens the ends of the bar, leaving it as shown at *B*; the second finishes the work of the first, leaving it as at *C*. Then the blank is turned over, the dies brought together, and the link bent together as shown in the chains. After the link is bent, it goes to a punch which finishes the hole and trims the outside fins, completing the link.

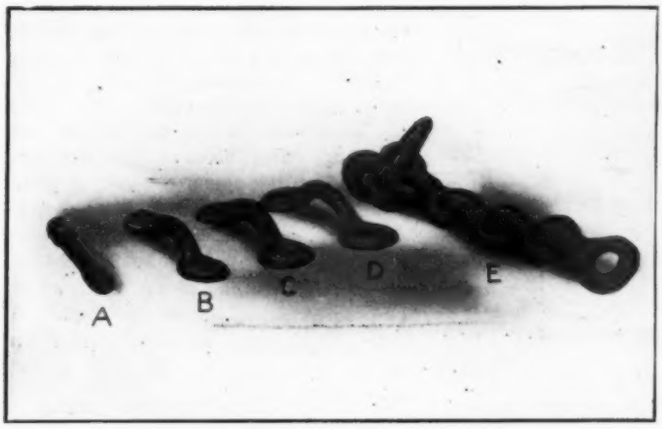


FIG. 1.- CHAIN IN DIFFERENT STAGES

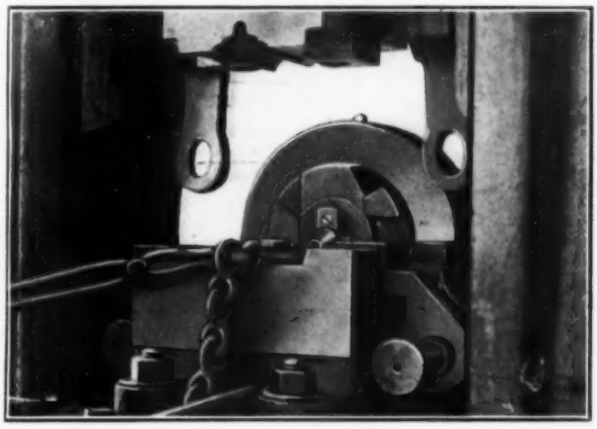


FIG. 2. BLANK IN PLACE FOR FIRST OPERATION

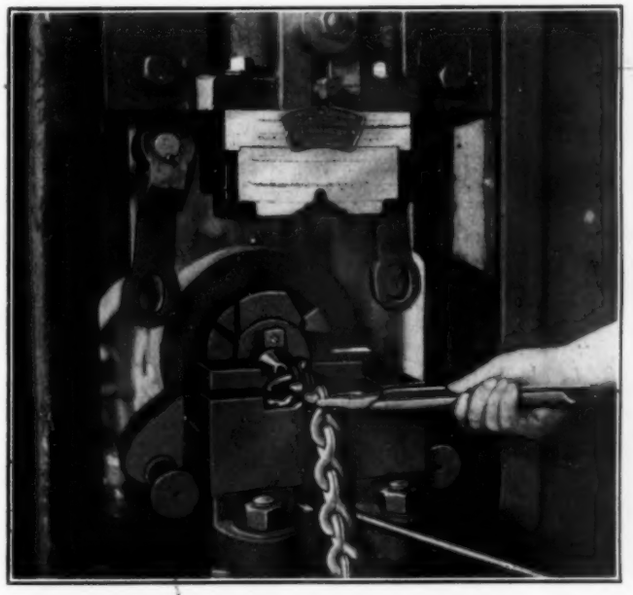


FIG. 3.- BENDING LINK UNDER SECOND DIE

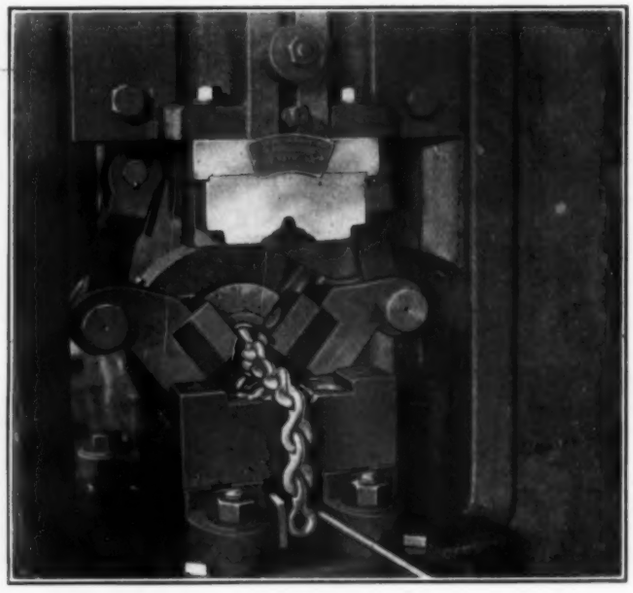


FIG. 4. CLOSING LINK BY RAISING THIRD DIE

Making the Second Link

The next operation is to heat another bar, put it through the hole just punched and place it under the first die as shown in Fig. 2 so the ends can be flattened as before. Fig. 3 shows the chain in the second die, while Fig. 4 is giving the final and most interesting operation of them all. The chain, which can be of any length, lies in the dies, the small central horn holding the finished link in position. The new link is turned over, the dies descend, the two pins at the side are slipped into the slots in the hanging links, the dies are raised and carry with them the third or bending dies, shown partly raised, and in this way the link is completed, save for the punching and trimming.

Joining Chains without Welding

They have a plan for connecting two sections of chain without welding which is very ingenious although a rather complicated and difficult operation. This plan includes the use of a weldless ring of half-round section as shown by the sketches in Fig. 5.

For a half-inch chain the ring *A* is about 6 inches inside diameter. The first move is to heat it and bend it double, making a half circle of half-inch round iron. One end is left open and the closed end is threaded through a link and back through the open end of the joining piece as at *B*. This is pulled down close to the link, the other end closed, threaded through the link of the other chain which is to be joined to

the first and the end opened out again as at *C*. Then the first chain, the one at the right, is threaded through the loop that has been opened up and when pulled down as at *D* the chains are joined, without a weld and ready to be forged in dies, to the same shape as the other links.

A Simpler Method

This operation requires many heats and a great amount of skill and patience, more than is apt to be found commercial in chain making, and we believe their second method will be found more desirable even if it is not theoretically as good. This method also has the advantage of being available for either joining straight pieces of chain or of making a chain endless, as may be desired.

This consists of making two saw cuts in the ends of the link, one above the other below, at the places shown in *E*. Fig. 5. These ends are then sprung open and the other link threaded in just as we work a key on a key ring. The parts are then closed together and makes a fairly strong joint. By welding the flat surfaces as well as the cut places, however, a very strong joint is made.

The dies and processes shown are only to show what can be done in making this kind of a chain, but the inventor has plans for a press which will be practically automatic and will turn out the work much faster than is possible with the tools shown with this.

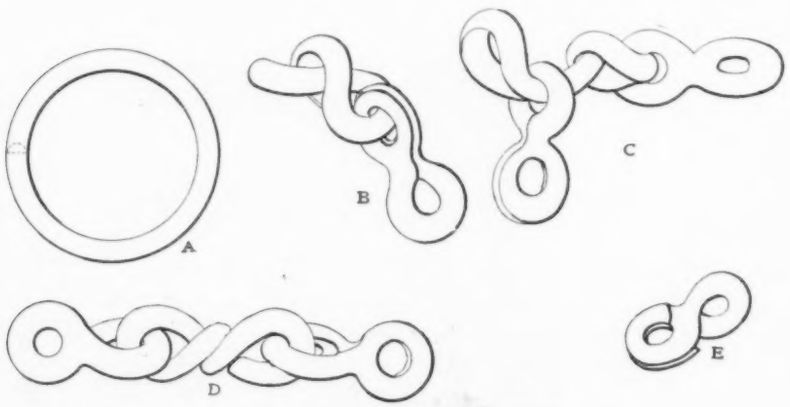


FIG. 5. JOINING THE ENDS OF CHAINS

The Screw Press Used

The press used in these demonstrations is new to most of us and has several novel features. Screw presses are used in small work but here is one in which the screw is something over 6 inches in diameter and used for large work as will be seen from Fig. 6, which shows one large press and a smaller one at the right.

Power is obtained from the friction disks, one running the dies down, the other raising them. The driving disks are fixed on the horizontal shaft and this is moved one way or the other, into contact with the large friction wheel at the top of the screw and here is where the novelty of the press lies.

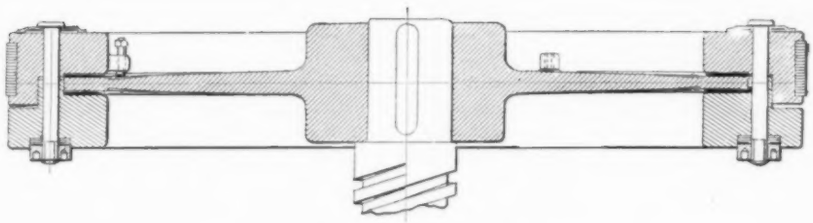


FIG. 7. SECTION OF FRICTION FLY-WHEEL

When a screw press, carrying a heavy wheel on the screw, is run down on the work it stops with a jar that is very noticeable and sometimes strains the uprights to the breaking point. To avoid this in a heavy press and yet get the squeezing effect between the dies, the fly-wheel on the screw is made in parts. One construction is shown in Fig. 7 in which the screw is keyed to the inner disk and this disk is clamped between the two parts of the rim of the outer wheel. This outer wheel carries the leather or fiber friction rings for contact with the driving disks and the inner or screw-wheel is also driven by friction.

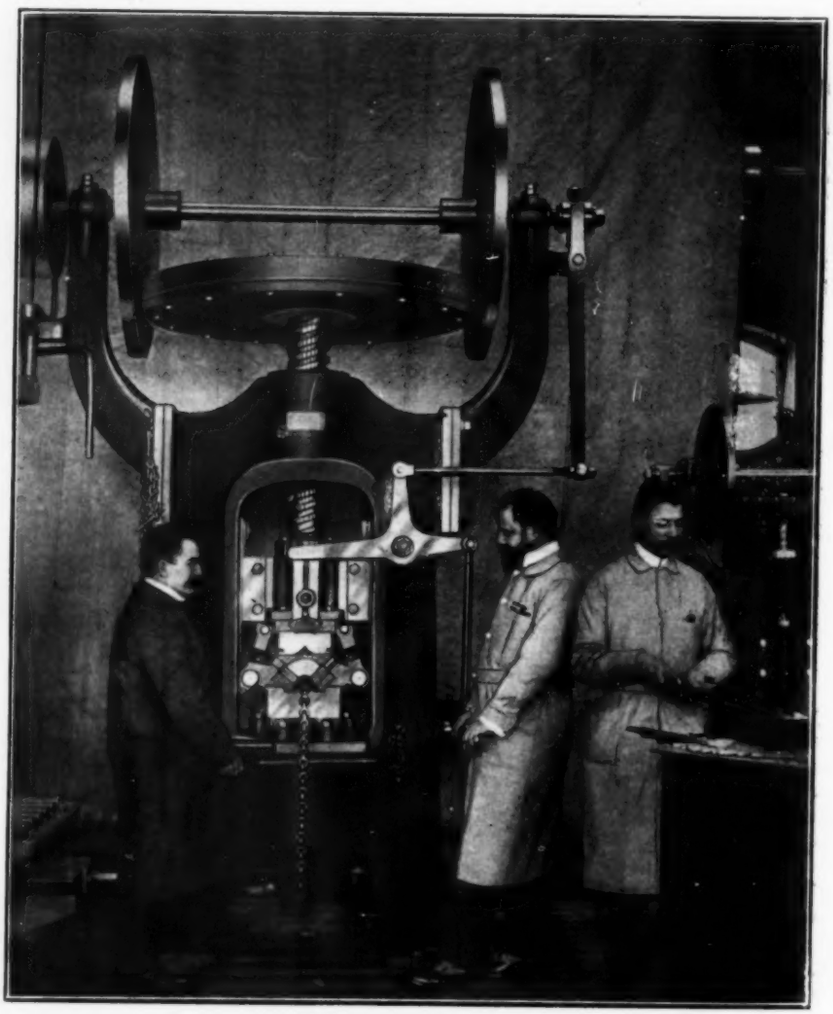


FIG. 6. SCREW PRESS WITH FRICTION FLY-WHEEL USED IN MAKING CHAINS

When the dies come together and the pressure reaches the desired limit, the outer wheel slips on the inner disk and relieves the press of undue strain. The amount of friction between the wheels can be adjusted as desired by the bolts shown in the rim and the inventor also has designs for regulating this by either hydraulic or magnetic means. It makes a very interesting device and, with the addition of a brake to stop at any desired point, it should be useful for many purposes.

The American representatives of the inventor are the International Import and Export Company, New York.

Machine-shop Sanitation

By A. H. Bartlett

The editorial on page 786 of the American Machinist, entitled "Suppression of Tuberculosis among Factory Operatives," is timely. The action of the group of Rhode Island men in forming an association for the improving of factory conditions, and especially in trying to mitigate the ravages of tuberculosis, is worthy of our commendation. An association with a similar purpose has its headquarters in Boston, named the Boston Association for the Relief and Control of Tuberculosis. This association issues cards which can be seen in many factories throughout New England, calling attention to the dangers of spitting on the floor. A portion of the legend on this card is as follows: "Do not spit on the floor. Cuspidors are provided in this room. If you spit on the floor, somebody who may have a contagious disease will do the same, with results positively dangerous to health." The association, in addition to furnishing these cards free to factories, endeavors to have the management provide and properly care for cuspidors at convenient points throughout its buildings.

There are two laws on the statute books of the State of Massachusetts which deal directly with the bettering of factory conditions for the employees and apply more particularly to machine shops. The first is a law passed in the year 1903 and requiring that emery wheels, belts or buffing wheels giving off dust injurious to health shall be connected with suction pipes and fan exhausters to remove the dust to a place outside of the building or to some closed receptacle. The second is in the acts of 1906, taking effect January 1, 1907, and provides that the proprietor of every foundry engaged in the casting of iron, brass, steel or other metal, and employing ten men or more, shall establish and maintain suitable sanitary conditions, including a toilet room, properly heated and ventilated, so that the men can have a place to change their clothing, and provided with wash bowls, wash sinks or other suitable appliances, with running hot and cold water.

We believe that a similar law in regard to washing appliances for foundries is on the statute books of Connecticut.

In connection with the spitting upon the floor it may be of interest to call attention to the fact that the sanitary code of the city of New York forbids the spitting on the floors of factories as well as upon the sidewalks of the city and in public buildings. It might be interesting to know to what extent this law is enforced.

In one factory in which I was recently employed the question of sanitation was very carefully looked after. This factory was really kept clean, and in that particular was the best one in which I have ever worked. All of the rooms were plentifully supplied with cuspidors and notices such as I have quoted from the Boston association were tacked up in conspicuous places. The cuspidors were rectangular boxes about 10 inches square and 3 inches deep, made from a single piece of heavy galvanized sheet steel. The corners were folded without notching and the top edge was heavily wired. The result was a strong, liquid-tight box without soldered seams. These boxes, after cleaning, were filled a little less than half full with fine sawdust. On the next morning more sawdust was added, making the box full to within about ½ inch of the top. On the second morning the contents of the boxes were emptied into a metal waste barrel or metal wheel-barrow, removed and burned. Each box was then thoroughly cleaned by boiling in a saturated solution of sal soda, allowed to dry from its own heat, and was then partially filled with sawdust and returned. The waste barrel or wheel-barrow, after being used, was scrubbed with the same hot caustic solution. This is surely an improvement over the old-fashioned wooden cuspidor or the usual style of metal cuspidor.

In this factory the floors were carefully swept and cleaned from one to several times a day, depending upon the character of the work; at intervals, varying from one day to a week, they were washed with a solution of sal soda or caustic potash. The potash was used in departments where the machine operations required a great deal of oil. The windows were also systematically washed whenever they became soiled, or at stated intervals, in order to admit all possible daylight and sunlight. All of these windows, except those toward the north and northwest, were provided with heavy shades, a feature directly administering to the comfort of the employees.

The toilet rooms were provided with concrete floors, which were mopped over carefully twice each day with a strong caustic solution. All of the utilities were carefully gone over each day with a strong disinfecting solution, and the slate compartments were kept carefully cleaned and oiled with a mixture of linseed and paraffin oils darkened with lamp black.

In a similar manner rooms used for washing and the storing of street clothing were carefully cleaned; in fact, all of these toilet, wash and locker rooms had a colored attendant constantly at work caring for the vital element of cleanliness. All of the factory sweepings and waste were carefully burned each day as fast as they accumulated. For this purpose a fire was kept burning continuously on a section of land which needed additional filling. Thus this refuse was disposed of in a thorough manner, so as to be no menace to the health of the employees.

Cool drinking water was brought to many convenient places throughout all the general manufacturing floors, and in the summer time this supply was iced; at a considerable expenditure of labor and money, as can readily be believed if one will only remember the prevailing prices for ice during the last two summers. The heating of the building was by the indirect system, which supplied a continuous quantity of fresh, heated air during the months of the year when heat was necessary, and at times during the hottest summer weather provided cool fresh air to make the rooms more grateful to the employees. The windows in this plant were quite large, and of course provided ample ventilation during ordinary weather.

Two other features for the benefit of the employees were an emergency hospital and a restaurant. The emergency hospital was equipped with instruments and appliances so that ordinary accidents and even minor operations could be cared for on the premises. This feature was very much appreciated by the employees, as during its first year of operation it averaged one case for every employee who had been in the plant during that period of time. The restaurant was capable of seating at one time about 550 men and furnished a regular dinner at noon for the sum of 20 cents. These features dealing with the welfare of employees and with the broad subject of machine-shop sanitation were worked out with a belief that they were features that the employer owed to the employees, and that only good could result from their use. While the broad subject of machine-shop sanitation is one that it is perhaps unpleasant to discuss, it is receiving more and more attention at the hands of progressive and intelligent employers of labor. We believe that the next two years will see such utilities finding their way even into the small shops of our country.

The wide use of gas engines by the United States Steel Corporation marks an important step in the progress of steel manufacture in this country, as they are designed to operate upon the hitherto "waste" gas developed by the blast furnaces; thus inaugurating an important economy in steel production.

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Cutting the Rates under the Premium Plan

In another column we publish an article in which the equity of a cut in premium rates when earnings go above the expected figures is raised, and our opinion on the subject is asked. It appears that a workman getting regular wages of 24 cents per hour has succeeded in earning a premium of 17.8 cents per hour, and that the manager is not satisfied with the results—saying that he objects to a workman earning more than 33⅓ per cent. of his wages in premiums, and that the premium rate should have been 1 to 10 instead of 1 to 3, in order to prevent the large increase; the manager basing his claim on the belief that there would have been a gain without the premiums, to which gain the employer is entitled.

So far as the gain due to repetition without premiums is concerned, it is easy to overestimate it. At the beginning there is naturally such a gain, but sooner or later it stops, the pace adopted soon becoming a jog trot without further progress. In the present case there seems to have been little reason to believe that this gain would have been a large one, because of the four workmen whose time is given but one succeeded in earning an increase which anyone can call excessive, and under these circumstances this increase must be considered to be due to special ability on his part, and to the results of such ability he is entitled just as much as a lawyer of superior ability is entitled to charge larger fees than one of less ability.

Moreover, comparing the increased earnings of this workman with the savings to the company, we are unable to see how any manager can object to the general result. As we figure it, while the workman has increased his wages by $1.78 per day, he has, in doing it, saved the company $5.43 per day in actual wages paid for doing the work, and at the same time increased the output more than 4 to 1. By any comparison that can be made this workman, even at the wages which he earns, and, indeed, because of these wages, is the most economical man of the four whose wages are compared. How any manager can object to the results with the right-hand column of the second table before his eye is beyond our understanding, and how he can expect any such results in reduced cost through the operation of the trifling premium which he suggests as proper, is equally beyond us. The manager may rest assured that any attempt to get the best of the premium plan by cutting the rates as he proposes will result in the plan getting the best of him, the result being a smaller output and an increased cost.

Perhaps the most fundamental fallacy of the manager's argument lies in his assumption that "a man drawing 25 cents an hour is presumably a 25-cent man in intellect and general ability." The fact which the manager overlooks is that in this case the man was not a 25-cent man. His superiority to his fellows is shown by his great increase of output as compared with theirs, and against this the fact that he had previously been paid but 25 cents per hour counts for nothing. If this superiority is due to his being left-handed, halt, lame or blind, he is still entitled to the results of the faculties which nature has given him. Cases like this are among the most common which the premium plan brings to light—the existence of unusual ability in unexpected quarters being one of the commonest discoveries to be laid to its credit.

It is of course important when setting the rates that sufficient experience should have accumulated to make them represent fair average production under the day-rate system. Nothing is said in the article about this factor, but with this possible exception we cannot see that the time-setter has made any mistake. The percentage given to the workmen is less than in many shops of which we have knowledge, but we believe it to be about right for most branches of machine-shop work.

The manager's fears that high wages will demoralize his workmen springs from the mistaken notion that he is his brother's keeper. We have no fears of any widespread demoralization as a result of any earnings that can be obtained from manual labor.

The fundamental idea of the premium plan is that there is to be no limit to a workman's earnings, except that set by his capacity to produce. Any manager who is not willing to look at the matter in this manner, and certainly any manager who is not willing to see a workman earn an extra dollar while he saves three, and incidentally multiplies the output by four, should leave the premium plan severely alone.

Standardization of Factory Accounts

In this issue is an article by Mr. Porter on "Cost Accounts," which suggests in a very brief and general manner the possibility of standardizing factory accounts for independent industries. As a particular instance, he cites the jobbing foundries as a field for such an attempt, and states that a movement in this direction is already on foot.

The value of definite and accepted standards in any field is so apparent that we are glad to recognize any real movement in such a direction. To some it may seem impracticable to arrange systematically the factory accounts of shops of different sizes and in different localities to conform to a general standard. The element of secrecy might be urged as a point which would be to a certain

extent sacrificed by such a course, as parallel systems would allow for leakage of detailed information which would be directly comparable by two competitive firms. A little consideration will show, however, that there are many elements entering into factory accounts which are already standardized. For instance, most machine shops pay their employees weekly; and, during the week directly following the one in which the wages were earned, raw materials, as steel, iron, brass, etc., are standardized in bars, rods, sheets and wire; to quite an extent the hours of labor are uniform; most of the elements entering into costs are the same for a given industry; methods of billing, routing and handling business with our great transportation companies are, to quite an extent, uniform today. Many other elements entering as basic data into factory accounts are, from the fact of their coming to the shops from a common source, uniform in character.

With many of these elements already standardized, is it too much to suggest a widening of the field until the broad principles of accounting shall be systematized, standardized and generally accepted?

Factory systems are the product of only a few recent years of our industrial efforts. They have sprung from many sources. In general, each plant has worked out its own results, although some specialists have entered the field and have worked out consistent, unified systems. The systems of too many plants are a product of growth, and on detailed analysis present an incoherent mass of data, each perhaps accurate in its way, but standing alone it is at the best only loosely connected with the other members of the factory-record structure. It is of course impossible to think of one factory-account standard capable of meeting all shop requirements even in an independent industry, for an endless variety of specified details must be met; yet is it not feasible to think of a basic standard, treating of the common and necessary elements of factory accounts, bringing them to a uniform system, yet allowing for variations of detail to suit individual requirements?

Apparently many advantages would result. Would not our business intercourse between firms be simplified if there were a standard for orders, requisitions, acknowledgments, shipping methods, checking of materials received, invoicing, billing, credits, payments, and so on? Would not the work of the factory paymaster be easier if factory employees were acquainted with a standard system of time keeping and paying off? Would not the office manager's duties be lighter if he could hire clerks trained to a standard system, the one he was using, and avoid the tedious and unsatisfactory "breaking-in" process?

This suggestion may be and is radical; yet any step which lends itself to simplification of the intercourse between man and man, and factory and factory, is worthy of our consideration.

Exhibitions and Exhibitions

Our readers will remember that one of the subjects discussed at the Fortress Monroe convention of the Machine Tool Builders' Association was the profitableness of exhibits at exhibitions, the trend of opinion being that, while the wisdom of exhibiting at large world's fairs is questionable, there is less question regarding special exhitibitions, of which those held by the Railway Master Mechanics' Association was named as a type.

The exhibition held in Philadelphia in connection with the convention of the American Foundrymen's Association offers a new illustration of the value of these special exhibitions and we doubt if any visitor to that exhibition has any doubt about the profitableness of the various exhibits.

There was a business-like air of enthusiasm and interest, which was in marked contrast with the listless aspect of the crowds in attendance at world's fairs. We have all seen how visitors to such fairs wander up and down the aisles looking for something to interest them and seldom finding it outside of a few spectacular exhibits. At the foundrymens' exhibition all this was replaced by the keenest interest, the exhibits being surrounded by those who had come to the show because they wished to find what it contained that might be applied to their own lines of work. The various exhibits were, of course, surrounded by the usual railings, but the visitors paid little attention to them. Whenever a demonstration was in progress the crowd invaded the inclosure, filled it full, watched the demonstration with lively interest, and after the demonstration was over proceeded to discuss it among themselves and with the exhibitor. Different exhibits of machines of the same class were discussed and compared, claims were dissected and the exhibitors were put upon the defense to justify their claims.

It is not too much to say that, in the line of molding machines for example, the discriminating and intelligent visitor could learn more about the progress in molding machines and the adaptation of different machines to various classes of work at this exhibition than was ever possible in the same length of time before. The exhibition performed an educational mission of large importance and there can be no doubt that the exhibitors will obtain results from their exhibits for years to come.

The show was held at the Second Regiment Armory, of which every square foot of the full floor space was taken, with a large overflow containing some of the best exhibits in an annex under a canvas cover. It was a creditable show in every respect and one which, in its line, will not soon be surpassed. Just as great world's fairs have undoubtedly been overdone, so exhibitions of this character have been underdone. Of their value and profitableness there can be no possible doubt and we expect to see a large increase in their number in future.

New Publications

WALLS, BINS AND GRAIN ELEVATORS. By Milo S. Ketchum, C. E. 388 6x8¾-inch pages, with 238 illustrations. The Engineering News Publishing Company, New York. Price, $4.

In the author's introduction he states that he has endeavored to place the design of retaining walls, and their allied structures, bins, on a scientific basis. The result shows that this endeavor has been followed with success. Yet the work is by no means entirely mathematical, for many examples of recent work are shown and data are given in regard to costs of materials and labor. The first 35 pages deal with the mathematical investigation of retaining walls, followed by 11 pages on the design of masonry and 20 pages on the design of reinforced-concrete walls. The treatment of reinforced concrete has an important place in all three sections of the work. The balance of Part I, 32 pages, gives examples and illustrations of walls, built mainly by railroads, and tables of materials and costs. Part II, 125 pages, is devoted to coal and ore bins, handled in a manner parallel to the treatment of walls, except that steel construction occupies an important place. Part III, 137 pages, discusses grain bins and elevators of timber, steel, concrete, tile and brick construction. The appendix of 26 pages gives definitions of masonry, terms, and specifications of masonry, concrete and steel construction as used in railroad work.

Electric Traction on a Steam Road

Combined steam and electric traction is to be employed for 38 miles on the Newton & Northwestern Railway, in Iowa, this stretch of line (between Kelley and Lanyon) serving as a link between a 25-mile branch to Des Moines and a 23-mile branch to Fort Dodge. Both branches are electric lines owned by the parties owning the steam railway, and form a line organized as the Fort Dodge, Des Moines & Southern Ry. The trolley wire is 21 ft. 6 in. above the rails, so as to be clear of brakemen on the roofs of box cars of the steam trains. Current is generated at 2300 volts, and stepped up to 22,000-volt, three-phase current for transmission. The cars are 53 ft. 6 in. long, with four Westinghouse motors and 36-in. steel wheels. Both express and passenger cars will be operated.—*Engineering News.*

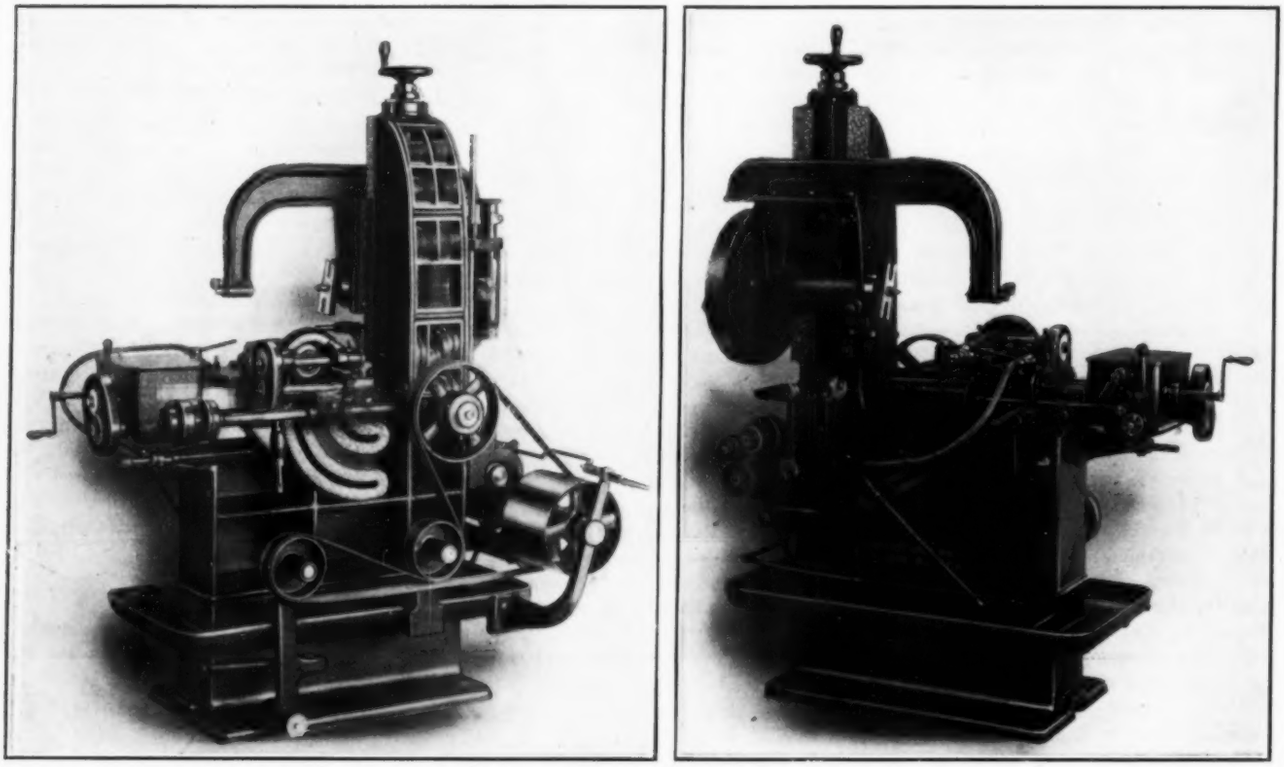
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

Large Automatic Gear-cutting Machine

The gear-cutting machine here illustrated has been designed for such work as lathe and milling-machine change gears, feed and adjusting spur and bevel gears, milling of face clutches, cutters and saws, and, in fact, all cylindrical or conical work requiring automatic milling, where either accuracy or rapid production, or both, are essential.



LARGE AUTOMATIC GEAR CUTTER

The machine has a capacity of 24 inches diameter, 6 inches face and 8 diametral pitch in steel, at a good feed. The construction follows the general design of the line of machines of this company, except where the size of the machine allows of different application of the same principles. This is shown in the bevel-gear drive to the cutter spindle, providing a very efficient drive, especially adaptable to the high spindle speeds required by high-steel cutters. The change of speeds is obtained by means of gears immediately driving the bevel pinion.

A segment, graduated in degrees, provides for cutting bevel and miter gears. This segment is operated by means of a worm meshing in the teeth in its periphery, thus allowing convenient adjustment. The slide can be raised to 90 degrees, and the machine is well suited for milling face clutches and similar work.

The strap shown in the front view of the machine is used as a brace to give additional stiffness to the slide when raised.

A screw is provided for adjusting the lower slide with reference to the column to allow for different lengths of hubs. A dial, graduated to thousandths, facilitates this setting. Graduated dials are also provided on the indexing worm, and on the cutter-spindle bearing, for rolling and shifting when cutting bevel and miter gears, and on the depth-adjusting screw, for setting the proper depth to be cut.

The indexing mechanism is positive and operates the master wheel, which is large for this size machine, as can be seen in the front view.

The outside support to the work arbor is adjustable for different lengths of arbors, but is always centered opposite the work spindle. This is especially convenient in a machine of this class, and allows rapid setting.

The illustration shows the work spindle with a 60-degree center and dog driver. This is furnished with the machine and is of use in such work as milling flutes in taps and reamers, for cutting gears on ordinary lathe mandrel, for cutting pinions solid with the shaft, etc. The center has a taper shank fitting the work-spindle hole, and is drawn in and forced out positively by means of a bolt operated by a handle at the back of the work head. The usual taper and shoulder nut arbors can be used for cutting gears, the hole in the work spindle being No. 10 Brown & Sharpe taper. The spindle is of machine steel.

The cutter arbor is solid with the cutter spindle on this size, and takes cutters with 1-inch hole. The chips are caught in the box on the side of the machine, and the oil runs through, being caught in the ample reservoir formed around the frame of the machine. The oil pump affords a constant stream of cutting lubricant and can be adjusted to regulate the supply.

This is known as the No. 2 B automatic spur and bevel gear-cutting machine and is built by the Eberhardt Brothers Machine Company, Newark, N. J.

A Few Practical Points in Gearmaking

By Frank Burgess

The development of the automobile industry and the use of high-speed gears have developed new conditions and new problems in the manufacture of gearing in general. Perhaps a person directly engaged in the commercial manufacturing of gears of many sizes and kinds appreciates this situation better than the average man in mechanical pursuits. It is my purpose, therefore, to treat briefly of a few of these practical points in connection with gearmaking and to show the tendency of the art.

Accuracy

The degree of accuracy required for most gears today is much greater than it was a few years ago. The increased perfection in building many lines of machinery has had its influence as well as the advance of the automobile industry. The high-grade motor car demands gearing which shall run at a very high speed, under severe conditions of loading and shocks and as noiselessly as possible. To meet these conditions accurate gears are required. While we have been able to meet these conditions with quite a degree of success, I am looking for still greater accuracy and still greater perfection in manufacturing gears in the near future. A high-grade gear should be accurate not only as regards the teeth but as regards all its other elements. The hole should be true and of the proper size. The keyways should be of the proper dimensions and accurately located. The blanks should be turned true and of exactly the right diameter. These details are sometimes overlooked or slighted even in gears which are supposed to be of a high grade. It is absurd to demand high-class cutting on a poorly machined blank. Yet this is the condition which the gear manufacturer sometimes meets with. The next few years are to bring us, I believe, increased refinement in the accuracy of gears in general and much improved methods for inspecting and testing.

Inspection

In regard to inspection, the tendency of the times is toward more rigorous specifications for all parts of gears, and detailed inspection to see that these specifications are properly met.

Increased perfection is demanded of the testing and inspecting instruments, fixtures and devices, and it is not enough to determine whether or not a gear will mesh and turn around with the master, but all of the elements must be accurate. This feature is one to which I am giving considerable attention at present, for with refined methods of inspection inaccuracies can be precisely determined and a proper starting point obtained for improved methods of manufacture.

Grinding of Teeth

The automobile has given us another problem in gearmaking, namely, the producing of accurate hardened gears. All steels distort more or less under fire treatment, and it is impossible to produce an accurate gear without resorting to some finishing process after hardening, to perfect the shape of the teeth. This, however, is not usually done. Gears which are to be hardened are cut with a certain amount of backlash in order to allow for distortion. This can be considered as an element of necessary inaccuracy. However, I believe that the better method is to cut the teeth a trifle large and then finish by a grinding process after the gears are tempered. In fact, I believe that the progress in the art of gear cutting is such that we can look forward to a time in perhaps the near future when all high-class gears will have their teeth ground to a perfect shape. This will eliminate another minor trouble or fault of inaccuracy, which is rough tooth surfaces.

Rough Tooth Surfaces

The question is sometimes asked: What is the relative effect of smoothness and roughness on gear-teeth surfaces? In answer, I think that it is a fallacy to believe that mere roughness makes noise. Noise is rather the result of poor tooth spacing and an imperfect form. A tooth that does not bear on its whole contour is an imperfect tooth and will make more noise than a tooth which is merely rough, or cut on a machine using coarse feeds for economy in manufacture.

A perfectly formed tooth begins to bear at the top, sweeps along its entire contour and will run more noiselessly than a first-class smooth-surfaced tooth which is out of shape. I have an idea that these rough faces act somewhat as cushions and after a little use wear away, giving a good surface and accurate action. Of course, the backlash may be slightly increased.

Stubbed Involute Standard

A good deal is being said nowadays about the short involute tooth, or, as it is usually called, the stubbed involute tooth. The main point of advantage claimed is greater strength, but I believe that it makes more noise than the old standard for gears with less than 20 teeth. The length of sweep of the tooth of a standard spur gear is little enough, and in the stubbed form it is considerably shorter. This standard was originated in the days when we had ordinary steels as our raw material. Today, with the special alloy steels, improved methods of working and knowledge of their capabilities, I believe that steel gears made to the Brown & Sharpe standard are amply strong for any ordinary service. A gear tooth cannot run successfully on one point. A long tooth usually gives a better movement than a short, stubby one. With the shorter tooth the pitch is proportionally greater for its depth and there is a tendency to jump from one tooth to another, especially for a pinion with less than 20 teeth, and this tendency results in noise. The noise in gearing is undoubtedly the result of shocks, jumps and vibrations caused by teeth coming into and going out of action. Irregularities in gear teeth and their spaces, although they may be very small, produce this condition. This brings me to another point: The advantages of a helical form of tooth.

Helical Tooth Form

I have watched with considerable interest during the last few years the increased use of helical and worm gearing. I believe this is in line with good mechanical construction. Spur gears such as are used in the transmission gear of automobiles will run with much less noise if made with the helical form of tooth than with the ordinary involute form. Worm gears are perhaps something of a mystery when it comes to specific design; yet I understand that it is being used to a very great extent in Europe for transmission gearing. Its adoption seems to be somewhat slower in the United States, but still it is growing in favor. I do not say that the helical form of tooth is right for all conditions, but it is for a great many. Metal gears running at a very high speed should have helical forms of teeth if they are to run noiselessly. In a pinion you are limited to the number of teeth—usually 18 to 22—and the running action is hard. In gears of larger size of comparatively fine pitch, not less than 100 teeth, the running action is much easier. This point I am sure needs no theoretical demonstration. With large gears you will get less noise with a given periphery speed than with smaller ones. In the pinion, with ordinary straight teeth, there is a constant succession of blows on the teeth, no matter how well they are cut, generated or planed. There are a tremendous number of interruptions, intermittent motions, hammering and vibrations, and consequently noise. With the helical form of tooth the action is very easy, as a little consideration will prove. Definite answers to questions of efficiency are perhaps a little hazy, yet I believe that efficiencies of 85 to 90 per cent. are possible. The question before mechanics and engineers is increased knowledge and improved design for the helical form of tooth. The question before the manufacturer is improved and more economical methods of cutting this form of tooth. I predict that in 20 years or less the helical form of tooth will be used universally for machinery of all kinds requiring speed, efficiency and noiselessness. This will eliminate the use of weak fiber and rawhide gears now used to reduce noise.

Distortion of Gears in Fastening to Their Shafts

In closing I will point out one element which may nullify the accuracy of the work of the gear cutter. This is in the method of fastening a gear to its shaft. If the shaft runs out, or if the shaft is a little undersized, or if the gear key bears on the top of the keyway and is driven home too hard, the gear may be distorted slightly and caused to run out. Set-screws will also help to distort a good gear. Then although the gear itself may be very accurate, in action it is no better than one imperfectly made. To my mind it is better to make use of some form of a clamping hub in connection with the gear's key, provided the design will permit, or even to use three keys, spaced equally around the shaft, instead of one. Either of these devices, or others which may be suggested, will overcome the element of distortion. It is unfair to the gearmaker to demand extreme accuracy in gears, and at the same time provide imperfect parts upon which these gears are to run.

A gear well designed and properly made, with accurately cut teeth, will perform wonderful duty and stand considerable abuse provided the material is well selected for its purpose. With modern scientific methods gratifying results are obtained, and many of the old gear troubles and complaints are seldom heard of and in most cases are entirely unnecessary.

Personal

W. E. Richmond, treasurer American Emery Wheel Works, of Providence, R. I., sailed the middle of June for France, for a combined pleasure and business trip.

A. R. Lentz, formerly superintendent of the Williamson Bros. Company plant at Philadelphia, has become general superintendent of the Heindel Foundry Company, Hanover, Penn.

Keeping the Line Shaft Clean—Erratum

At page 846, Vol. 30, Part 1, last column, sixth line from bottom, for "moving body slips" read "moving body stops."

Diamond Powder and Its Use—Erratum

At page 567, in the article "Diamond Powder and Its Use in the Machine Shop," the price should have been 85 cents instead of 85 dollars per carat.

Business Items

The Wirt Electric Company, Philadelphia, Penn., has been purchased by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., makers of electric motor controlling devices.

The Ridgway (Penn.) Dynamo and Engine Company, builder of the McEwen Engine and the Thompson-Ryan dynamo, has appointed Samuel W. Hay's Sons, 302 Farmer's Bank building, as its Pittsburg sales agent.

Trade Catalogs

Norman W. Henley Publishing Company. Catalog and pamphlets of scientific and practical books.

Buffalo Forge Company, Buffalo, N. Y. Folder of new blacksmith tools. Illustrated. 8 pages, 3½x6½ inches.

Curtis & Curtis Company, Bridgeport, Conn. Catalog of pipe cutting and threading machinery. Illustrated, 38 pages, 7½x10 inches, paper.

Rockwell Engineering Company, 26 Cortlandt street, New York. Bulletins Nos. 10 and 11, illustrating and describing rod and bolt heating furnaces.

Diamond Chain and Manufacturing Company, Indianapolis, Ind. Catalog containing standard dimensions of power chains and sprockets. Illustrated.

Norton Grinding Company, Worcester, Mass. Catalog No. 7, describing plain cylindrical grinding machines. Illustrated, 64 pages, 6x9 inches, paper.

American Spiral Pipe Works, P. O. Box 485, Chicago, Ill. Catalog describing forged and rolled steel pipe flanges. Illustrated, 94 pages, 8x10½ inches, paper.

D'Olier Engineering Company, 119-121 S. Eleventh street, Philadelphia, Penn. Bulletin, Series T, No. 8, illustrating and describing centrifugal and turbine pumps.

Manufacturers

The citizens of Calhoun, Ga., will vote on the question of building an electric light plant to cost $11,500.

A new foundry building will be built at the plant of the Iron City Sanitary Manufacturing Company, Zelienople, Penn.

The Corn Products Refining Company, Granite City, Ill., will erect a can factory to manufacture cans for its own use.

The Armstrong Cork Company, of Pittsburg, Penn., has prepared plans for a linoleum plant in Lancaster, to cost $500,000.

Rumsey & Company, Seneca Falls, N. Y., pump and engine manufacturers, are preparing plans for an addition to the foundry.

C. J. Matthews & Company, morrocco manufacturers, Philadelphia, Penn., have purchased site for a plant in Langhorne, Penn.

The National Wrought Iron Annealing Company, Anderson, Ind., will move to Washington, Penn., where a new plant will be erected.

A plant is being erected for the Statesville (N. C.) Safe and Table Company. This will consist of a machine building, finishing building and dry kiln.

William Whitman, of the Arlington Mills, of Lawrence, Mass., will, it is announced, build a cotton mill in New Bedford, to cost about $1,000,000.

The American Foundry and Casting Company, Dayton, Ohio, has been incorporated by W. J. Rosencrans, John T. Dietz, James J. Kilcoyne and others.

The Western Maryland Railroad is to enlarge and double the capacity of the shops at Elkins, W. Va. J. L. Barlow, Baltimore, Md., is chief engineer.

The Menominee (Mich) Insulated Electric Wire Company has been organized with $100,000 capital. A plant to employ 200 people will be erected.

The Arrow Motor Vehicle Company, St. Louis, Mo., has been incorporated by Augustus Ross, Herbert O. Ross, and John Tackaberry. Capital, $25,000.

The Vilter Manufacturing Company, Milwaukee, Wis., builders of engines, ice machinery, etc., will build a new machine shop and pipe shed to cost $30,000.

The Westinghouse Interests have purchased a site in Sharpsburg, Penn, where a large machine shop will be built. Several hundred men will be employed.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

We desire a few more machines or specialties to manufacture. Box 423, Troy, N. Y.

Machines designed and built. Walter S. McKinney, M. E., Broadway, Flushing, N. Y.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

C. W. Clifford, M. E., working and patent drawings and tracings. 643 N. 44th St., Philadelphia, Pa.

Wanted—To buy or lease small machine shop; state terms and equipment. Box 110, AMERICAN MACHINIST.

Special machinery built to order; let us estimate on your work. Capital Foundry and Machine Company, Frankfort, Ky.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

We will do your manufacturing for you; well established and equipped foundry and machine shop. Emmert Mfg. Co., Waynesboro, Penn.

Well established concern will pay royalty for several good patented machines or tools to manufacture. Emmert Mfg. Co., Waynesboro, Penn.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Draftsmen: Cliffords book of alphabets, for titles, sign painting or show cards, valuable to every designer; limited number only; price 25 cents; write now. C. W. Clifford, 643 Belmont ave., Philadelphia, Pa.

Potter and Johnson 8½x16 automatic turning and chucking machine wanted at once; second-hand machine in good condition, acceptable; communicate with American and British Mfg. Co., Bridgeport, Conn.

A well equipped machine shop and foundry desires to add to its output by the manufacture of articles of brass and iron which

would find a ready sale in the South; correspondents invited. Box 122, AM. MACH.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

An old established firm with modern tools and equipment is desirous to communicate with an American firm to manufacture for them in Canada a line of light or medium weight machine work. Box 79, AM. MACH.

Engineer and machinist, member A .S. M. E., formerly chief engineer and superintendent of large steam pump works, desires to represent a firm in New York as engineer and salesman; available September. Address "Expert," AMERICAN MACHINIST.

Manager or superintendent; practical, wide and successful experience, with good executive ability, desires correspondence from parties in need of an up-to-date, energetic and loyal man; all correspondence strictly confidential. Address Box 114, AMER. MACH.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th street.

Advice; mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

To manufacturers and others; a resident of Sydney, Australia, will be in New York early in July, desires to obtain a general agency or as representative; weighing appliances and mechanical goods a specialty; references and security if needed, pending arrival. Box 108, AMERICAN MACHINIST.

We have a special proposition for a few bright, energetic mechanics, such as foremen, draftsmen or machinists in different sections of the country; no canvassing or selling of any kind and while not interfering with your regular work pays well for the time taken; we want only practical men who can be depended on to give the little time required each week; further particulars on application. Box 102, AMERICAN MACHINIST.

Situations Wanted

Clasification indicates present address of advertiser, nothing else.

CANADA

Young English inspecting engineer desires responsible position; 27 years of age; 2 years English Government inspector, also experience in Germany and India, at present in good position with large Canadian engineers. Box 133, AMERICAN MACHINIST.

CONNECTICUT

Patternmaker, technical and with years of practical experience wishes a position as instructor in patternmaking and molding. Box 82, AMERICAN MACHINIST.

An experienced man in the design and construction of machinery for automatically machining metal parts; also in the design and working of large double action and combination dies; work similar to furniture and cabinet parts in sheet steel; broad experience, practical, technical, and a good executive; now in charge of department in large manufacturing concern, wishes to change. Box 135, AMERICAN MACHINIST.

ILLINOIS

As general superintendent with broad gauge manufacturers of some kind of light accurate interchangeable machine; replies desired only from those who can use a man of A-1 ability and who are willing to pay liberally therefor. Box 126. AMER. MACHINIST.

MASSACHUSETTS

An original and up to date man wants charge of a machine shop or department in New England, Massachusetts preferred; Boston references . Box 88, AMER. MACHINIST.

Position as superintendent by capable mechanic; organizer and executive; experienced in practical present day methods of interchangeable manufacture, and successful manager of men. Address Box 134, AM. MACH.

General superintendent desiring change solicits corespondence from concerns desiring the services of a practical mechanic who is a successful organizer and executive; unquestionable references as to ability and character. Box 451, AMERICAN MACHINIST.

MICHIGAN

Situation as foreman metal pattern maker; thorough and up to date on both stripping and vibrator work. Box 128, AMER. MACH.

NEW JERSEY

Position as foundry foreman, up to date and a hustler well up on light and heavy work and molding machines. "T. R.," AM. M.

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Thoroughly experienced export manager desires position with large manufacturing concern which wishes to build up its export trade; 15 years in the business. Address "R. O. P.," AMERICAN MACHINIST.

Wanted—Position as factory manager or superintendent by one thoroughly familiar with the design and manufacture of gas, gasolene and producer gas engines and producers; capable of producing the best results. Address "Reliable," AMERICAN MACHINIST.

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General foreman or foreman at liberty; wide experience, systematic; cost reducer. Box 116, AMERICAN MACHINIST.

Draftsman; nine years' experience in shop and drafting room, technical education; desires position. Box 119, AMER. MACHINIST.

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Advertising manager who has planned and managed money-making campaigns for machinery, engineering, contracting, automobile, and architectural firm is open for engagement; experience embraces the designing, writing, and placing of copy, preparation of articles, catalogs, circulars, follow-up letters, and other printed matter; salary $2500. Address B. C. T., Room 1029, 225 Fifth Ave., New York.

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Toolmaker with some experience as foreman and some as designer on special machinery and tools wants a position where he can be useful; technical education and twenty years' experience. Address Box 130, AM. M.

PENNSYLVANIA

Works manager; age 34; married; now employed; first-class references; reasons for changing at interview. Box 127, AM. MACH.

Draftsman; 30 years, graduated in Germany; 5 years' experience, especially in hoisting and conveying machinery, 2 years in America; highly recommended for all-around work; wishes to change position. Address "R." Box 121. AMERICAN MACHINIST.

Experienced woman invites correspondence from manufacturers of machine tools, or in any mechanical line, with a view to position as publicity manager; thoroughly competent to handle printing, illustrating, and the preparation of copy. Box 103, AMER. MACHINIST.

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WISCONSIN

First-class mechanical engineer; 29 years of age, with experience in steam turbines, steam boilers, water wheels and governors as specialty wants to change. Address Box 129, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

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Wanted—One toolmaker; one high-grade turret lathe man for bar and dry work; one expert wood working machinery man as inspector. De Loach Mill Mfg. Co., Bridgeport, Ala.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn. *

Wanted—Die makers for sheet brass and steel work, accustomed to accurate work; steady employment and good wages to competent workman. Address with references, experience, etc. Box 123, AMER. MACHINIST.

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Large company building line of duplex direct-acting steam pumps and hydraulic machinery want a first-class head draftsman; good position for the right man; state experience, age, etc. Address Box 95, AM. MACH.

Wanted—First-class hustling general superintendent for machine works in middle west, employing one thousand men; open shop; splendid labor conditions; a good position for the right man; state experience. Address Box 96, AMERICAN MACHINIST.

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MASSACHUSETTS

Wanted—Master mechanic for steel foundry located in New England; experience necessary on crane repairs, pumps and foundry machinery; good opportunity for a progressive man; state age and experience. Address "C. S. M.," AMERICAN MACHINIST.

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Wanted—Six first-class erecting machinists; also 3 gas engine erecting engineers; state references, experience, and salary expected. Box 35, AMERICAN MACHINIST.

Wanted—A practical mechanical engineer with technical education by factory in the middle West who manufacture gasolene engines and air compressors; good salary to a man of brains and ability; good future; state age, salary, references and past experience. Address Box 131, AMERICAN MACHINIST.

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We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

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Wanted—General foreman for machine shop; competent man capable of handling at least 150 men; must be a hustler. Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

Wanted—A metal pattern maker in machine shop, vicinity Albany, N. Y. Apply stating salary expected and experience to Box 97, AMERICAN MACHINIST.

Thoroughly experienced machine shop or metal goods factory cost clerk who has had experience on estimating; can read drawings and who is familiar with materials; only A-1 men need reply stating experience fully and salary expected; confidential. Box 90, AM. M.

Mechanical engineer able to fill position as master mechanic of soft metal rolling mill; no application will be considered unless accompanied by full and detailed experience, unexceptional references required; state salary expected. Box 136, AMER. MACHINIST.

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OHIO

Wanted—Experienced punch and shear draftsman; state qualifications, age, and salary expected. Box 70, AMER. MACHINIST.

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Wanted—A first-class general foreman; one with electrical experience preferred; must be thoroughly up to date and able to handle men and jobs so as to insure maximum output; a splendid opening for the right man. Box 98, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Lathe, planer and boring mill hands. The Blaisdell Machinery Co., Bradford, Pa.

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For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

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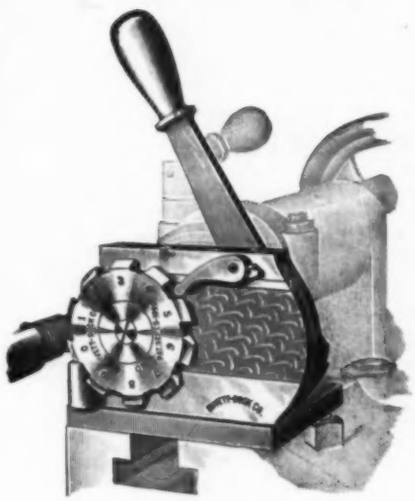

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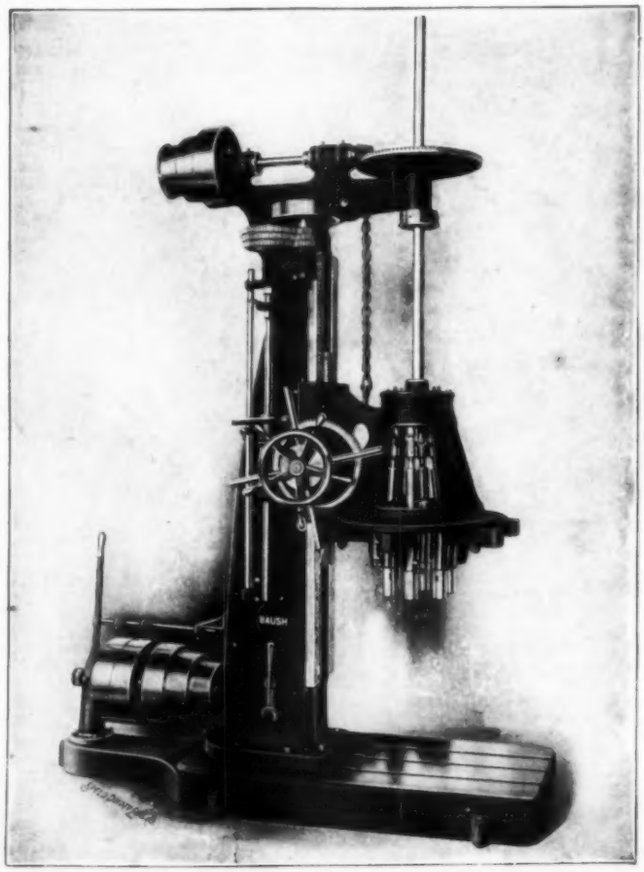

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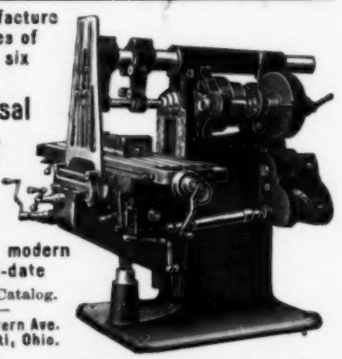

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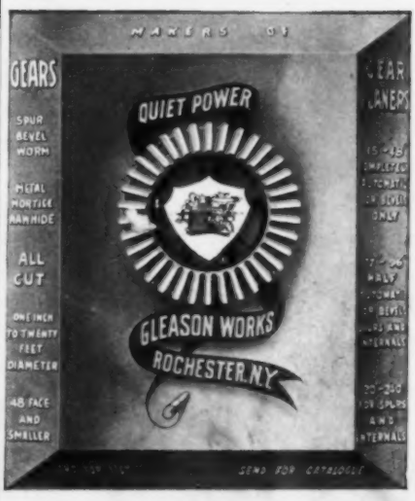
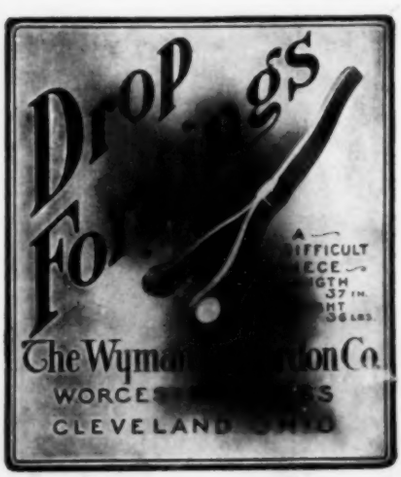
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